Understanding Computers

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Foreword

With the nation-wide computer-communication network, NICNET, becoming fully operational in 1988 connecting all the 446 District Headquarters, all the State Capitals and Union Territories and the National capital, a new era in informatics has dawned in India Under this facility, a computer and an earth station will be installed by the National Informatics Centre in the offices of every District Collector/Magistrate. In the wake of this information revolution, all administrators will benefit by NICNET and many may find it necessary to learn to interact with the computer First of all, there is need for de-mystification of the computer and make everyone understand that now-a-days a computer is user-friendly and even school children can learn to use it as demonstrated by the Computer Literacy and Studies in Schools (CLASS) Programme of the Ministry of Human Resource Development.

Within the next decade, the Government administrators cannot transact their work without knowing how to query a database in the computer. De-mystification is also necessary to understand in general terms, the various subsystems constituting the computer. The present book by Shri Dinesh Kumar, Collector & District Magistrate, Dholpur, Rajasthan, is an attempt in this direction. It is all the more important that it is coming from an IAS Officer who has a technical background. In various districts, a number of District Collectors have taken initiative to develop computer programmes for land record information system, district administration, rural development information system, among others With the successive conferences of District Collectors/Magistrates organised on the initiative of the Hon'ble Prime Minister, the need for a responsive administration is being increasingly recognised Adequate, accurate and timely information is an important component of a responsive administration. The computer is a tool enabling this. This book, "Understanding Computers" can give the first exposure to the principles underlying computers.

N. Seshagiri
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Government of India

New Delhi
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Preface

Since the introduction of the Personal Computer by IBM in 1981 the microcomputers have become the most popular and useful class of computers. They are versatile, easy to operate and inexpensive. Thousands and thousands of readymade programs for all types of applications which can be run on these computers are available at very low costs. Millions of people all over the world are already using IBM-PCs and what are known as compatibles, and thousands of new users are joining them every day. These computers have literally caused a silent revolution in our lives and it is high time that we understand and use them

Many people are in a state of confusion or even panic when it comes to computers For the one who is thinking of buying a computer, selecting a computer that best meets his requirements may be a confusing and frightening experience. He has to face many problems not explained by computer suppliers or manuals or books. What is a computer? What are Personal, Home, Desk Top, Portable, Laptop, multiuser computers? What are ROM, RAM, Hardware, software? What are different types of floppies, hard disks, keyboards, printers, monitors, operating systems, computer languages? What is graphics? What are application packages and which ones suit your applications best? Where are they available? These and many other questions keep boggling the minds of prospective buyers. The purpose of the book is to reduce the confusion and dispel the panic it should help you to get into the realm of understanding

Here is the essential information about what computers and their various components are and how they function To what use they can be put and how you should go around for buying the best The book gives a comprehensive view of computers and what all the reader should know before going for one. It is intended to help the buyers to make sound selection from the bewildering array of products and packages in the market. It's designed to be an aid in the decision making process

If you already have a computer, the book will make you understand and appreciate your system more thoroughly. You might discover new features for better use and upgradation of your computer.

The book is 'reader friendly' in that, it is specifically written for those with no previous knowledge about computers It aims to introduce you to the fascinating world of personal and microcomputers in a readable and friendly way. The book is an attempt to present complicated information

in simple terms and to bring it together at one place, the information that is generally found scattered at many sources and at higher technical levels It is designed·

(i) as a self teaching manual for a reader who is curious and wishes to learn about computers and what everybody is talking about.

(ii) for a prospective buyer of computer, who is planning to purchase one for home business, game or any other use.

(iii) as a textbook for a student who is taking introductory computer courses- classes X,XI and XII of Indian schools

(iv) as a supplement to more advanced courses

(v) for quick reference for a user already familiar with computers.

(vi) for teachers.

(vii)for training institutes offering training on computer software and hardware.

(viii) for the computer hardware/software manufacturers and suppliers, to supply the book with their products,

The technology and the offers from various manufacturers are changing so fast that part of the information in the book is likely to become out of date sooner or later. However, the concepts are going to remain the same. Once you understand the theoretical concepts behind computers, you have a basis for evaluating what you read and hear through other sources The reader is requested to keep in touch with magazines, newspaper, books, user groups etc. to gather the latest

My efforts would be rewarded if after going through the book, you could boldly say that the computers are not incomprehensible, that they are friends. And also if it can help you in making a firm decision, whether you should go for a computer or not, if you already do not have one.

There are likely to be mistakes. I would be grateful if they are pointed out to me

DINESH KUMAR

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I am thankful to the authors and publishers whose books I have read, consulted and used in putting together the information in this book. It is not possible to individually thank them as they are large in number and also because many of the references I have forgotten since I took up writing of this book some three years back. I have greatly benefited from their knowledge and experience.

I am grateful to my wife Madhulika and son Simant, who have silently and bravely borne my physical and mental absence from them when I got heavily involved for a few weeks with the preparation of the manuscript.

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DINESH KUMAR

Contents

1. Introduction

Since the discovery of automobile, electricity, telephone, radio, television, plastic, rubber etc., the most significant development that has directly affected our lives is the computer. It has changed the way things are done and has caused a revolution in all walks of life. Computers have become permanent part of our lives & they are to become world's number one industry very soon

Some of us have a number of questions and doubts regarding the usefulness of this new device and the impact it can make on our lives *Let's try to resolve some common doubts & questions.*

Fear & mistakes

Most of us are very apprehensive and fearful about the computers. We think the computers are huge and complicated devices and that they commit horrible mistakes.

Computers are now available which are very small and easy to operate & not complicated at all. Also, computers don't commit mistakes. In fact, a human being makes a mistake and blames the computer. A computer is like any other machine. It is as good or as bad as the person who uses it.

Jargons

For being 'pally' with the computers we have to learn some jargons and some new concepts, like we learn before driving a car. The terms like ignition-key, steering-wheel, fan-belt, etc., were jargons when the automobile was first introduced to us. Today these are common terms and we no longer are scared of them The same thing is soon going to happen with computers.

Experts

We normally think that computers are huge, expensive devices, and can be handled only by highly trained professionals, that we need experts for computers to do something for us.

That was true with the earlier computer systems. The latest computers have removed the breed of intermediary and we can now 'talk' to the computer ouerselves. We can now buy a computer like we buy a television, take it to our room or even to our car and ask it to solve our problems Like we need not know the inside of a car to successfully drive it, we do not need to know the inside of a computer to use it We can use a computer like we use a telephone, a television, a radio

Change

The human being does not like a change, particularly a rapid change, but computers have not given us that liberty The development of computers within last 15 years has been so fast that we did not have time to think about them or adjust to them. The technology has developed faster than we could change At the same time the computer has become inexpensive and therefore an indispensable tool The computers have arrived in offices, in schools, in homes, they are even transportable. They literally seem to be everywhere

User Friendly

Computers are now 'user-friendly'. We have now got very small, cheap & easy to operate computers & yet very sophisticated in their capabilities.

Due to this 'User Friendly' atmosphere, a new kind of society, an 'information society' is slowly emerging which does not approach computers with anxiety or fear We may or may not be feeling it but Computers are making us move from an industrial society into an information society. Their friendliness is helping us in doing our work more efficiently and effectively. By now they have become very friendly and helpful to us and we on our part should make friendship with them.

Computer Literacy

The phrases computers, microcomputers, personal computers, chips etc., are gradually entering into our day-to-day language. This very generation has already started taking to computers in a routine manner. Children are taking to computer courses run by various government & private institutions and the computers are being introduced gradually in many schools in India. The next generation will grow with computers. Children will

know computer terminology and use the computers like we use a TV & Radio today.

The magazines, televisions, business executives and others are all making us feel that we are not completely educated if we do not have a chance to use a computer This is causing a lot of psychological pressure on us to keep with the fashion of the time The time has come that if we are not 'Computer Literate', we are *behind the present generation.*

It is not late for us. We too should learn about computers, because they are inexpensive and useful

This book may help you in achieving the goal of making you a computer literate, to make you learn what computers can do and how to use them.

2. Generation, History & Classification of Computers

Computers can be classified in a number of ways. The first & generally known is the 'Chronological' Classification.

With the passage of time, the technology used in making of computers kept improving. The computers grew rapidly after World War-II, and since then, based on the level of technology used, the period since the first computer to date is divided in five generations.

The earliest computers which used vacuum tubes are called the first generation computers and successive developments have given rise to 2nd, 3rd, 4th and 5th generations. The youngest generation, our generation, the era of 'Artificial Intelligence', is the 5th generation The age of each generation can be broadly seen as:

Period	Generation	Length of period
1946 to 1960	1st	About 15 years
1960 to 1965	2nd	About 5 years
1965 to 1970	3rd	About 5 years
1971 to 1985	4th	About 15 years
1985 onwards	5th	Continuing

First Generation (1946-1960)

The first Electronic Computer of this generation was developed during World War-II in University of Pennsylvania by J.P. Eckert and J.W. Mauchly and completed in 1946 It was called 'ENIAC' (Electronic Numerical Inegrator And Calculator Machine)

The idea was to develop a device that could have twin function of determining missile trajectories and predict the weather. The machine was, however, later used for a number of business and government applications like prediction of elections

This was the faster machine, one thousand times faster than the machine using electric relays, and could bring five thousand additions or 350 multiplications in one second. The idea of the hugeness of the machine can be had from the fact that it contained 80 thousand vacuum tubes, 70 thousand resistors, 10 thousand capacitors, 60 thousand switches Its weight was 27 tonnes, occupied 2 rooms (3 thousand cubic feet) and consumed 150 K.W. of power This machine did not have any memory, was based on decimal system rather than binary on which later machines are based

Just to have a comparison, today's IBM-PC weighs a few Kg, uses a few watt of power and yet is more powerful, reliable, faster and much cheaper than ENIAC

The main characteristics of the First Generation Computers were:

* Used vacuum tubes like diodes, triodes, resistors, capacitors
* Were very bulky in size and weight and occupied large spaces
* Had long start-up time (Tubes had to be heated).
* More amount of heat was generated and, therefore, had to be heavily water-cooled to avoid overheating
* Tubes were burnt out & had to be freqently replaced. Thus, high failure rate or short life.
* Had limited memory.
* High power consumption.
* Programming capabilities limited.

(ii) UNIVAC-I, was also developed in 1951 by Eckert and Mauchley through their universal Account Company (UNIV-A-C)

(iii) International Business Machines Corporation, the computer company known all over the world as IBM, introduced the computers IBM-701 and IBM-650 in 1954 The 650 Model was the first digital computer.

Second Generation (1960-1965)

The invention of transistors in 1948 by Nobel Laureates John Burdeen, Walter Brattain and William Shockley, made modern computers practical.

The transistors due to their small size, lower power consumption, low heat production, low failure-rate and dependability; replaced in no time the vacuum tubes of First Generation

Computers. They opened the gates for further technological developments to be used in later generation computers.

The transistors improved speed of operation substantially, about thousand times more than First Generation. The increase in memory size was possible in this generation. Examples are IBM-700, 1401, UNIVAC 1108, Leo Mark-III, Atlas etc.

The second generation computers used faster & heavy duty peripherals like tape drives, magnetic disks, line printers etc.

Third Generation (1965-1970)

In the early 60's, 'Integrated Circuit' or 'chip' was developed. An I C. contained hundreds of transistors, capacitors, resistors on a single small chip. The ICs had higher speed, small size, large storage capacity low heat production, low prices, etc.

One class of computers of this generation were called 'Mini-computers' to distinguish them from First and Second Generation, and because they used chips, reducing computers to micro size. Examples are PDP-11, ICL-2903,CDC-1700.

The characteristics of third generation computers are·

* replacement of transistors by LSI chips on circuit boards.
* reduced repair time since defetive boards could be easily removed & replaced/repaired.
* tremendous reduction in size
* reduction in processing time to nanoseconds
* reduction in heat generation.
* efficient utilization of CPU.
* multiuser, time-saving, multiprogramming available

Fourth Generation (1971-1985)

In the early eighties, very large scale Integration (VLSI) gave rise to microprocessor chip. One chip smaller than the size of a finger nail could contain thousands & thousands of components like transistors, capacitors & resistors. The entire computer circuitry could be kept on a single board.

This technology gave birth to microcomputers (also known as personal computers). We shall be covering them in great detail in a separate chapter.

Table 2.1

Historical Landmarks—At a glance

Year/ Period	Device/Development
B.C.	Static electricity, number system, human hand
Birth of christ	Abacus
1642	Pascal's Desk Calculator
1671	Leibnitz's Mechanical Machine (Binary)
1800	Battery
1801	Jacquard's automatic loom
1833	Babbage's analytical engine
1854	Boolean algebra
1890	First true tabulation or data-processing machine
1906	Vacuum tube
1938	First electronic vaccum tube digital computer
1944	Mark I Electro mechanical computer (Relay)
1946	ENIAC
1947	Transistor
1949	Von Neumann's stored program
1954	First transistorized computer
1957	First high level language
1959	Integrated circuits
1964	IMB-360, integrated circuits computer
1970	LSI Circuits
1971	Microprocessor, One chip calculator
1978	16-bit microprocessors
1980	32-bit microprocessors
Future	Artificial intelligence

Fifth Generation (1985 onwards)

During the 80's a new concept, the concept of computers who can 'think' and take 'decision', is materialising. This simulation of human thought process with computers is called 'artificial intelligence. The fifth generation computers have the characteristics.

* Simulation of human thinking process, capabilities of 'Artificial Intelligence'
* Phenomenal speed of operation.
* Powerful software
* Large & compact memories.
* Can handle extremely large data bases

Microprocessors with 1MB (1000KB) memory have already been developed. Laser technology is widely being employed. Optical (laser) disks with 'super-high' memory capacities, beyond 1000 MB (1000,000 KB) have been developed. Laser printers with "super-high" speeds which can print a full page in less than a second (more than 20,000 Lines per minute) are available. They are presently costly but research & development and mass production is likely to reduce their costs drastically when all computer users would be able to afford them

Recognition & acceptance of human speech, human handwriting would make them extremely versatile Acceptance of spoken & written commands in day to day language like English is possible & shortly such computers would be available widely to general users

Classification of Computers

Computers can be classified in number of ways:

Generations: The first is the chronological classification. With the passage of time, the technology involved in making of computers kept improving. The earliest computers which used vacuum tubes are called first generation computers & successive developments have given rise to second, third, fourth, and the 'youngest' generation is called the fifth generation

Functions: The functional purpose for which they are used, they c be classified as general purpose or special purpose computers

Table 2 2

Computer Generations & Typical features

Parameter	I	II	III	IV	V
Examples	IBM-650, IBM-701 UNIVAC-I	IBM-1401, CDC-1604, IBM-1602	IBM-960, ICL-1900 CDC-6000	IBM-30330, HP 3000 HCL, IDM, Apple II Micros	—
Year	1946	1960	1965	1971	1985 Onwards
Electronic Components	Vaccum tubes	Transistors	Small & medium scale integrated circuits (chips)	Medium & large scale integrated circuits (microprocessor chips)	VLSI Microprocessor chips in parallel architecture
Number of circuits	10^3	10^4 - 10^5	10^6 - 10^7	10^8 – 10^9	Super high
Space requirements	large	medium	small	normal table top	Hard held
Heat generation	very high	low	very low	extremely low	extremely low
Cooling arrangement (airconditioning)	extensive	moderate	less	room A/C adequate	liquid coolers in built
Power requirements	very high	low	very low	extremely low	extremely low
Failure rate (as failure rate)	very high (about 1 hrs)	low (about 10 hrs)	very low (about 100 hr)	extremely low (about 1000 hrs)	years

Speed	very low	average	high	very high	super high
Reliability	low	medium	good	excellent	excellent
Maintenance	*constant*	constant	not much	negligible	negligible
Accuracy	low	high	very high	very high	extremely high
Switching time (microseconds)	100-1000	1-10	0 1-1	0 1—0 01	
Time for one operation (nano seconds)	10000	300	5	1	0 3
Main memory	10 KB	Magnetic core (100 KB)	High Speed *Magnetic core (1MB)*	semi conductor *(10 MB)*	super high
Operating system	No O S (simple monitors)	No O S (later batch operating system)	O S included (Time shared)	improved O S (single, user *fullfledged*')	Highly Sophisticated O.S
Nature of processing	serial	serial	serial/ parallel/array	parallel/ array	associative
Input/storage	punched cards disks, MT	cards, MT, *disks* VDU, MICR, OCR	VDVs, Floppies, optical disks, COMs	VDVs, Floppies, optical disks, COMs, winchester disks	speech signs, thought waves,

Storage capacity		10 MB	100 MB	1000 MB	super high
Languages used	Machine (low-level)	Assembly & high level FORTAN etc	High level COBOL, ALGOL etc	High level, PASCAL Query word	High level Karnel language, quary (new low-level)
Number of users	1	1	Multiuser	remote user	remote user
Application packages	No	No	programs to control I/O & many routine tasks easier, done manually	excellent packages available	excellent packages available
Quantity in the world (appx.)	1000	5000	35000	2,00,000	5,00,000
Other features	mainly batch processing	Multi programming, time sharing & real time	Remote processing & time sharing through communication	audio response terminals, graphic display terminals, networking, bubble memory	
Application	Mostly scientific Later simple business	Extensive business application, Engineering & science batch oriented applications	Data Base Management on line systems, airlines, market,	PCs, distributed systems, CAD/CAM, Real time control,	Almost everywhere

Principle of Working: The principle of their working is also a base for their classification and they are called digital or analog or hybrid computers

Processing Mode: Yet another classification is dependent on the *processing mode. Batch processing, Real time, dedicated to user,* time sharing, etc.

Size & Cost: Depending on the physical size and cost of the computers they may be classified as Large Scale (mainframe), Medium Scale, Minis, Micros, Desk-Tops,etc.

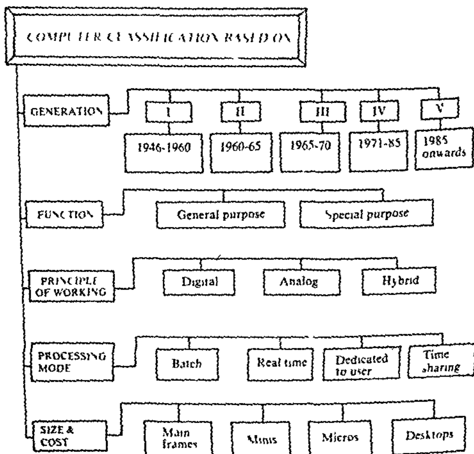


Fig 2 1 Classification of Computers

Mainframes

The Mainframe computers are huge and occupy large spaces. They are more powerful and can handle large amount of information & are very expensive. Till 60's they were the only type of computers available.

They require airconditioning and only experts can handle them It is this type of computers which have created a curtain of 'Secrecy' and make us 'apprehensive' about the computers.

These computers require a definite site, the user will send his data to the Computer Experts who would then go to the Computer-room to process the data and obtain printouts and supply to the user The computer is inaccessible to a general user

However, this inaccessibility of Mainframe has somewhat been reduced by the development of 'Distributed Data Processing'. This means that number of terminals are linked to the Mainframe and data can be entered or accessed from these terminals away from the computer.

Many a times a microcomputer is used as a remote terminal so that apart from functioning as a near terminal to the mainframe, it can also be used as a full fledged independent normal microcomputer.

The future of the mainframes is not in danger but the development of 32-bit microcomputers would definitely affect these 'large computers'.

Minicomputers

Minicomputers developed in the 60s are useful when one cannot afford a mainframe. They are mainly 16-bit & 32-bit and were developed in a period when the manufacturers of the computers had also to develop their own ICs and Operating Systems. The 'third parties' had not yet taken birth who would develop application software and operating systems like in case of 'Micros' The result is that minicomputers mostly use their own proprietory chips & the operating systems

Since the coming of microcomputers, the market for minicomputers has suffered a lot. Earlier a minicomputer was powerful compared to the micro but that presumption no longer holds

good The introduction of microprocessors like Motorola-68000, Intel-80286, and recently the new 32-bit, Intel-80386 have given tremendous boost to Micros and soon they would leave the Minis behind.

More powerful micros are available which are cheap compared to the minis and are expandable in terms of disk storage capacity and the number of video screens they can support. The prime reason why the Minis are still being sold and used for many applications is because of the availability of great amount of excellent software specially written for them. 'System Houses' or 'O E.M 's.(Original Equipment Manufacturers) selling the mini-computer hardware and software are gradually shifting to micros. These Companies are converting their programs written for minis to run on micros. Some other companies are diverting operating system which can run on both minis and micros. Some of the minis had advantages that they could be used as 'Multiuser Installation', particularly the 32-bit ones, but with the coming of 32-bit micros, those minis are also likely to go out of the market. The minis, therefore, do not have a bright future. The intensive support on the software alone will not be enough to keep the minis alive

TABLE 2.3

Comparison of Mainframe, Mini & Micro Computers

	Mainframe	Mini	Micro
Example	IBM 370/168 (USA)	PDP-11 (USA) TDC-316 (India)	IBM-PC (USA) HCL-Busybee, EIKO (India)
Cost (Rs.)	1-10 crore	5-25 lakh	0 2 to 5 lakh
Memory capacity (8-bit bytes)	8-64 MB	256 KB-8 MB	8 KB-256 KB
Word capacity (words)	500 KW-10 MW	4 KW-2MW	512 W-32 W
Processor add time (microseconds)	0.13	0 9	2 00
Max I/O data rate (bytes/sec)	16 M	4 M	1-5 lakhs
Languages	all	all	Basic, Pascal, Fortran, Cobol PL/1, etc
Size of CPU	Large	Small	On a single chip

ipherals	Alltypes like laser printers very high speed disk 1000 MB High speed tapes	Wide variety like line printers winchester disks	Floppy disk hard-disk magnetic tape cassette tape key-boards Home TV
Software	All types	Almost all types	limited
Speed (register to register add cycle) (microseconds)	0 1 to 1 0	0 4-4 0	30 to 2000
Word length (bits)	64-96	16-64	8-16
Types of applications	Large scientific & engineering applications, on-line application with large data base	Time shared systems in industries Engineering CAD CAM	Payroll, home, games, individual, professionals etc
Back up storage devices	Alltypes	Hard disks, magnetic tapes	Floppies, hard disks, tapes
Number of terminals supported	Above 100	up to 20	One

3

Microcomputers & Personal Computers

Microcomputers—The Latest Generation

Since the first computer was developed about 40 years back the computer industry has been expanding both horizontally and vertically. As mentioned earlier, the successive generations of computers have drastically reduced the space reuirement, the cost, the expert's need in operation of the computer. The stringent conditions of environment are also relaxed. The latest generation of computers, the Microcomputer, are making tremendous impact on our lives.

The word 'Microcomputer' is used for every thing from a Home Computer to a powerful Business Computer. Technically a microcomputer is defined as the one which has a single microprocessor (or a chip) and this is how it is distinguished from minicomputer.

They were initially developed as hobby machines for the computer amateurs. However, their value for education was soon recognised, and they began to be used by schools and colleges In the last few years, their potential even for serious business applications was explored & realised.

The microcomputers depending upon the kind of applications for which they are being used, are known by various names. Other names used for them are 'Personal Computer', 'Desk-top Computer', 'Home Computer' & so on. There are other equipments like programmable calculators, intelligent terminals, hand-held computers, lap-held computers, etc, whose operation is based on stored programs and therefore, they also must be called as microcomputers.

They are low-priced, costing as little as a few thousand rupees, & are sold off-the-shelf by manufacturers & retailers They are purchased rather than rented or leased. They plug into regular home & office electric outlets. They can indeed operate on a desk-top. Normal office airconditioning and humidity control is

sufficient. They are usually single user machines. One machine is intended for one person at a time, solving one problem at a time.

They are creating thousands of new users every day, covering applications which could not afford computerization earlier. These computers have made the benefits of computers available to the general users. It has become an easily accessible commodity like telephone, television and typewriter. Soon it would become an essential commodity for schools, small businessmen, administrators, homes, professionals, non-professionals, virtually everybody.

Although programs can be developed and run on a micro, the majority of business applications use pre-programmed packages. It's more difficult and time consuming to write programs for a micro than it's for a larger machine because programming aids for micros are not as readily available.

They have a wide range of capabilities. Earlier, because of floppy disk storage limitations, they were limited as to the total volume of work they could handle, however, the availability of hard-disk-drive has improved the reliability of micros for regular & advanced business use.

The Factors for Growth of Microcomputers

Lets us investigate what factors have been responsible for the smashing success & growth of microcomputers.

Three developments around 70s have been mainly responsible for revolutionizing the field of computers & we shall briefly discuss them:

1. Microprocessor
2. User Friendly—Application Software
3. BASIC Language

1. Microprocessor

In the early 60s the integrated circuit which could contain several transistors, resistors, capacitors on a single small case, was developed. The technology of Large Scale Integration (LSI) followed soon which permitted hundreds and thousands of components onto a single Chip. In 1970 a new type of Chip called the 'Microprocessor' was developed and it is this

Table 3.1

Comparison of Mirco & Minicomputers

Parameter	Characteristic
Advantages of Minicomputer	
Versatility	More. Have better addressing scheme with larger word lengths.
Speed	Faster than Micros
Address Mode	More efficient & wider application.
Internal registers	Larger in number. Therefore, necessity of frequent memory refreshing during the execution of programs minimised. Execution time reduced.
Interrupt schemes	More sophisticated.
Programming facilities	Standard facility in terms of a common. programming languages not available Due to variety of bit microprocessor available poses problems in training and of intercompatibility.
Advantages of Microcomputer	
Cost	More cost effective.
Application	Number of application packages available
Utilization factor	Much high than mini.
Reliability	higher than mini & require less maintenance
Mean repair time	Very much reduced
Design production & testing time	Effectively reduced
Future	would displace the minis from many applications.

entity which made the 'computer -on-a-chip' or 'Microcomputer' or 'Personal Computer' possible.

The earliest computer 'ENIAC' had eighteen thousand capacitors, weighed *thirty tonnes, occupied three thousand cubic feet of* space & used one hundred fifty kilowatt of power To compare with the present Personal Computer, the IBM-PC weighs a few Kgs, occupies a normal table space, costs a few thousand rupees and yet is much faster and powerful than 'ENIAC'.

Like the printing press that caused a revolution by making books available to everyone at low cost, the technology of Large Scale Integration has made the microcomputer accessible to everyone A computer system can now be purchased at a few thousand rupees which occupies a table top and yet do the work of a computer that would have cost crores and required big *rooms, only 20 years back. The early computers were within the* financial reach of only large companies, large business houses, research and development organisations, Universities, Government agencies, etc. But the microcomputers due to their cost effectiveness have found thousands of new users

2. User Friendly—Application Software

The technology of Large Scale Integration alone could not have produced 'Computer revolution' unless the computer could be used easily. The earlier computers could not be operated without expensive training, and the experts who had this training alone could operate the computer.

A very important development is the emergence of 'User Friendly Computers' The term 'User Friendly' describes computers, programs, instructions which are developed for the people who do not have computer background or training. Earlier computers required people who could design computers, develop programs, write instructions for the computers, and if there were problems with the computers the experts who 'ran' computers could only figure it out and solve it. The latest class of computers, the Personal Computers, do not involve this approach We have now got small, cheap & very sophisticated computers with the noncomputer users in mind. Gradually, manuals which can be easily understood & programs wich can be easily run on the computer are available

3. BASIC Language

For a computer to do anything useful it must be given a set of instructions that tell it what to do. These instructions are called

'Programs' or 'software'. During the time of earlier computers the programs were not of much use to a general user. The instructions were written in a way that was easy for the computer to understand but very difficult for the people. Only experts who were highly trained could program a computer.

A very simple computer language, almost English like, called 'BASIC' (Beginners All purpose Symbolic Instructions Code) was developed in 1963. The development of this language made computers accessible to thousands of general people who could play games, draw pictures and have fun with the computers. This ultimately led to the serious use of microcomputers in business applications.

The Microcomputer Family

Microcomputers are known by various names depending upon the kind of applications for which they are used or the physical features of the machines.

Personal Computers

Personal Computing is the use of a microcomputer by an individual, small group, family or businessman for recreational, business or other personal purposes.

Business micros which came in later 70's were often derived from 'Home Computers' and they were suitable only for use by individual users rather than for handling the computer needs of a company as a whole. This use by individuals gave rise to the term 'Personal Computers'. The overall needs of a company were met better by a mini-computer.

With the passage of time, however, micros have developed in terms of performance and can meet the requirements of not only one user but of an entire company. In addition to that, the Personal Computers are now available which can be upgraded into multiuser systems through the use of multiuser expansions like IBM-PC/AT.

The primary reason why the word 'PC' is being used or would continue to be used for microcomputers is that the world's most successful microcomputer introduced by IBM is called a PC. Most of the manufacturers now identify and compare their products

with the IBM-PC and the term PC has been accepted by almost everybody in the computer industry.

Home Computers

Home Computers are used for playing games, for education and for learning programming. Both business & home computers are microcomputers, where they differ is in their capabilities. Home Computers are often not suited for business purposes though, some Home Computers can be upgraded to business computers by adding external devices Often the cost of upgrading is very high and buying a new business computer would be cheaper.

Typical Home Computers are BBC-Acron, Commodore-64, Sinclair spectrum etc. There are some computers which are in between Home Computers and Personal Computers and which can serve the purpose of both, like Sinclair QL

A Few Words About Some Models

BBC Acron: Typewriter style keyboard, 32K memory, cassette tape and disk drives Single unit 100 KB & double unit 800 KB, other peripherals like printer available

Commodore 64: Typewriter style keyboard, 64 KB memory, Dot matrix and daisy wheel printers, disk drives and Cassette units available.

Sinclair Spectrum: Keyboard, memory 16KB. A version with memory 48 KB available, data stored on cassette tape of sinclair microdrive, stores around 85 KB of data Upto eight micro drives can be linked together with total storage capacity 680 KB

Sinclair QL: Much more sophisticated machine with 32-bit processor, 128KB RAM, two built in microdrives and a full size keyboard. It also comes complete with four software packages, a *spreadsheet, word processor, database and graphics package.*

All these machines which offer colour graphics, have to be attached to an ordinary television, because they are not supplied with a monitor

These machines (except Sinclair QL) and others such as Dragon, Commodore VIC 20, have sold very well. This is because they provide a low cost introduction to computers and because a amount of software, usually game and home finance

program, is available for them. Their potential for serious business use is limited because they lack good quality business software and storage capacity Although sinclair QL may prove to be an exception.

Portable Computers

A large number of microcomputers have been developed for mobile users. They are very small and compact and can be easily carried by a person from one place to another These portables can be divided into two categories:

(i) Those which are easily portable and
(ii) Those which are not.

Lap Held Portables

They are light and small and can fit comfortably on your lap They are about a foot long and weight is between 2 to 4 Kgs. They use L.C.D. screen and Gas Plasma Displays The system consists of a screen & a keyboard and both can be folded together when not in use.

They suffer from the disadvantage of low resolution, poor eligibility of the screen in the case of L.C.D models, and they do not come with internal floppies. The software is generally permanently put into the ROM which means you cannot have a choice of packages. Also, you have only limited scope for data storage unless one adds external floppy drives costing extra since they do not come as part of the portable package.

The advantages of Laphelds are that they are really portable and are used by those who need to work with a computer while on the move, such as, surveyors, construction engineers, salesmen etc. They are useful as communication devices in that the information collected in the field can be transmitted to a computer in a central location simply by connecting the micro to a phone.

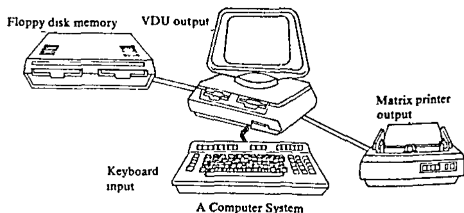
Transportables: They are large and heavy but have many features About 2 feet long, they weigh about 10 kg and are not easy to lift and walk with. The prime reason for their bulkiness is that they use CRT screens which occupy a lot of space.

They have almost all the advantages of a desk-top computer like floppy disks, full size keyboard, integral screen displaying 25 lines by 80 characters with perfectly good

The transportables are bought by people who require some mobility but do not need to use a computer while in transit and generally get around by automobiles.

Portable Screen

Till recently the only screen which was available was the Cathode Ray Tube (CRT) like the one used for TVs and desk-top microcomputers. CRTs are several inches thick and very bulky. They are alright for desk-tops and give very high resolution but are not useful for portables which require less bulky screens. In the portables, therefore, two other technologies are used, Liquid Crystal Display (L.C.D.) and Gas Plasma Display.



A Computer System

Figure 3 1

Liquid Crystal Display (LCD): The LCDs have become cheap recently. The advantages they have over CRTs are that LCDs are virtually flat, they are about 1" deep and, therefore, less bulky than a CRT. The disadvantages are that the LCDs do not offer good resolution & are hard to read particularly on a bright day.

Gas Plasma Display: The Gas Plasma screens are as compact as LCDs but offer much higher resolution. The technology however, is new and expensive and it would take sometime before Gas sma Screens become common in portables

Table 3.2

Comparison Between Large & Small Computers

Parameter	Earlier or large Computers	Personal Computers
Operating system	sophisticated	Minimal
Capacity	almost unlimited	Limited
Reliability	good	Mixed (good with hard disk)
Architecture	Box or Board	Chip.
Cost	Extremely expensive costing lakhs of Rs. A major capital expenditure.	Few thousand rupees
Space requirements	Large, complete floor of an office room.	Very little, literally desktop i e., 4' x 2½' space sufficient
Ease of programming	Good	Good
Airconditioning	Absolute requirement	Not so rigid, normal temp. in office alright
Humidity	absolute control	Preferably required, normal humidity in office alright
Use	If large amount of data at high speed is processed, large financial savings can result	Medium volume of data at moderate speed
Professionalism	Computer professionals, system Analysts, programmers, operators, etc., required	For most applications operator or a typist would be sufficient

Run time	To be run 24 hrs to be cost effective Down time Min	As & when required may be used like a typewriter
Application packages	Special programs have to be developed by experts.	Standard ready-made packages for immediate use available without need to know programming
Availability	Few weeks to months	Mostly ex-stock, off-the-shelf
Operation	Tedious.	more or less like a typewriter
Training	Required	User can learn in 2 hours
Use friendly	very little	Very much
Weight	Can't be carried by one person	Portable models can be carried by one person
Number of users	Limited,prerogative of scientists,engineers, big industries, research and development etc.	Increasing by thousands every day, literally a 'home' computer and soon to become an 'house hold' item like TV, Telephone, Typewriter, etc
Installation	Requires weeks/months	Immediate after purchase, easy installation
No of users at one time	Very large to two	Normally one (more than one on IBM PC/AT)
Application package cost	Very high	Few hundred rupees

Light Emitting Diodes (LED): The cheapest kind of portables do not have full size screens. They use L.E.D. (Light Emitting Diodes) strips of about 8 lines by 20 characters. LEDs are what one sees on pocket calculators, digital watches, etc.

History of 'Personal Computer'

In 1959, Second Generation Transistorised Computer began to replace the First Generation one At that time, the abundance of Commercial Computers and knowledge gave birth to computer hobbyists and amateurs.

Personal Computering began with the Home Computers and by 1966 books and articles on building Home Computers started appearing in which some amateur successes were reported.

A real computer revolution occurred in 1971 when Intel Corporation produced the first microprocessor, Intel-4004. However, it was a costly and not very successful device. In 1972 a cheaper and very sophisticated microprocessor, Intel-8008 was produced. Use of this chip was also limited due to shortage of support chips needed to create a full and working 8008 Computer System. The 8008 was followed in 1973 by Intel-8080 chips. This chip was costly at that time but available today at a very low price. Soon more powerful chips Intel-8088, Intel-8086, Motorola-68.000 and Zilog-Z-80 followed and the Personal Computering had taken a complete birth.

The first Commercially Manufactured Personal Computer Kit was announced in 1973 by Scelbi Consultancy Company. Its 8H Computers were based on Intel-8008 chip.

In 1974, many companies offered computer kits that could be assembled by users. These kits used Microprocessors such as Intel-8080. The assembled computer was about the size of a home Stereo System. The best known kit of this time was 'Micro-8' using Intel-8008. These kits were not very successful since assembling and operating of them required some learning of electronics.

The first really successful computer kit was 'Altair 8800' manufactured by Micro Instruments Telemetry System (MITS) in 1975 and was based on Intel-8080.

Between 1975 and 1977 a lot many other companies joined in and offered Microcomputers to users from all walks of life.

A second manufacturer of computer kit was I M.S. Associates later called IMSAI. Whereas the MITS sold its kits mostly to hobbyists, the majority of IMSAI Kits were sold to business people

The kit manufacturers during this period had several problems. The most common complaints heard were the lack of professionally written software and reliability of the computer. Many manufacturers produced computers that did not work properly and were not dependable These Personal Computers were purchased only by the individuals who could write their own programs Lack of good quality software was a big problem.

The real Personal Computer market started when Apple, Commodore and Radio Shack introduced their Personal Computers. Their computers are called 'Third Generation Computers' which were designed specially for a user without the background of computers or electronics. All these computers come in assembled form and are designed such that one has to only unpack the system, plug it in and start operating immediately.

The Apple Computer Company introduced Apple-I in 1975 and a second design was developed in 1976. In 1977 the first high end Computer, 'Apple-I', was introduced and since then the Apple Computer has remained an important Personal Computer manufacturer.

The Commodore Business Machine entered the Personal Computer market by storm and announced its first Computer PET (Personal Electronic Transaction) in 1977

The Radio Shack introduced its TRS-80 model in 1977 which has spread in many directions Today the Radio Shack is one of the largest Personal Computer Manufacturer in the world.

In 1978 and 1979 new Personal Computers were introduced by many companies but before 1981, the front-runners in the Personal Computer market were three companies i.e. the (1) Apple, (2) Commodore & (3) Radio Shack.

In 1981, the Osborne Computer Company announced its 'Observer-I' portable computer. The machine had two unique features One, portability & two, availability of impressive

business-oriented software programs at low price. The combination of inexpensive & portable computer, and excellent software brought immediate success to the company. Within a year another company Kaypro Corpn introduced 'Attache' and 'Kaypro II' portables. These companies created a revolution in the field of portable computers.

The actual thing happened when IBM entered into the Personal Computer market with the introduction of IBM-PC, on August 12, 1981. It helped tremendously in 'legitimizing' & cementing personal computering. Companies of all sizes & businesses began to avail the advantages of PC systems. This created market competition for the PC & many small companies sprang up, offering their own microcomputers the so called 'IBM-PC-Compatibles'.

Micro or Personal Computer Market — The recent trends

New Developments

A number of things have happened to the personal computer market since 1977. Developments in the areas of sound synthesis, voice synthesis, voice recognition, colour graphic, operating characteristics, large memory capacities, reduction in the cost for equivalent feature, etc., have taken place.

Big VS Small

Number of big manufacturers like IBM, Atari, Soni, Hitachi, Canon, D.E.C., etc. have entered into the market in a big way. The surprising development is that even after their entry, the small computer market earlier cornered by Apple, Radio Shack and Commodore still continues to be dominated by the latter three. The growth of new entrants even as big as IBM has not affected the small computer market which is in fact expanding rapidly and newer & newer models for small computers are becoming available & selling successfully.

Another important development is in regard to the application software. A new computer will not be successful unless a large amount of software is available for the model.

Specialisation

The latest development in the personal computer market is that it is beginning to specialise. Earlier micros (III generation)

were general purpose. One machine was sold for all purposes whether home, office, education or active professions. These models are now disappearing. Newer models are aimed to attract any one particular segment of the market.

Recession

It appears as if the first phase of the micro boom that began in the 70s is over. Since 1985, the market is witnessing slight recession. A number of companies have become bankrupt. Sick companies have been taken over by the others. Many big companies like Commodore, Apricot etc. have not produced very good results.

However, no major manufacturer, with a significant share in the computer market has been eliminated from the micro market. The collapses have more been among smaller ones. In some of these smaller companies also, the collapses didn't occur due to market-pressure but due to substandard products and poor management.

Also, the downtrend has affected the manufacturers of home computers and not of business micros. In fact, the home and business micro markets have different characteristics and problems, and should be studied separately.

The micro-market is over crowded by suppliers. There are not enough customers to keep every supplier successful. In the coming years, some more manufacturers are likely to withdraw from the market. But it seems that none of the big names will leave the market. The fluctuations in the performances of some companies like Apple, would not throw them out of the market, due to their very solid bases.

Presently, as a result of establishment of industry standards (such as IBM-PC) in the micro industry, it is easier and economic for entrepreneurs to start manufacturing (or rather 'assembling') the micros and sell successfully. In earlier days, a manufacturer had to design a original system and then find people to develop software for it, then alone he could survive in the market.

4.

ANATOMY OF A COMPUTER

We are living in a period of 'computer revolution' or rather 'microcomputer revolution'. The base of a microcomuter, the microprocessor, has revolutionized many aspects of our lives. They have computerised watches, calculators, televisions, video games, Home computers, personal computers and large number of other devices. The question arises what is a microprocessor ? What is a microcomputer ?

Before we talk of a microcomputer we need to know about a computer.

COMPUTER: A computer is a machine that processes data. So far as a computer is concerned this data has to be numerical If we have some non-numerical data, such as, alphabetical character, punctuation marks etc., this has to be translated into numbers before the computer can work upon it.

A computer can be very large or it can be very small. It can be very complicated or as simple as digital watch or a pocket calculator.

To perform even the simplest task, a computer has to be told exactly how to do it. A computer operates under a 'program' meaning that actions of the computer are governed by a series of commands or instructions that make up a 'computer-program'. When a computer executes a program, it carries out the instructions the program contains. To carry out the instructions the computer must read the program instructions, interpret them and then execute them. Technically 'reading' is known as 'fetching', 'interpreting' as 'decoding', & 'executing' as 'performing.'

Most people think that a computer is a machine that can do calculations very fast. That is, of course, true but that is only one of the features of the computer. It has many other qualities In general a computer is a device which can perform some or all the following functions·

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Storage—

It can store large amount of information within it and can ake it avilable to the user when required

Data processing—

The computer can do various operations on the data, technically it is known as 'data processing'

This involves

(i) Performing calculations, such as, addition, subtraction, multiplication, division etc.

(ii) Performing—logic/comparing—data— The computer can perform logic function and can compare two numbers or alphabets and arrange them in desired sequence.

(iii) Editing of text— In application of word processing, the *business documents can be prepared easily and efficiently.*

(iv) Graphic action— The computer can draw maps, pictures, designs etc. for planning and designing.

(v) Production of data— Result can be stored on various devices like tapes, disks etc., can be printed out on paper or can be displayed.

(vi) Communication—The results produced can also be transferred through communication devices like telephones.

The Capabilities & Limitations of a Computer

A computer is a machine and like all machines, it has to be directed and controlled by its user to perform a task. Until a program is prepared and stored in the computer's memory, the computer knows absolutely nothing, not even how to accept data. No matter how good a computer is, it must be 'told' what to do. The following are the capabilities and limitations of the computer.

Repetitive Operations: The computer is a very powerful tool for a mathematician, an engineer, a scientist, a businessman & so on. It does repetitive & complicated calculations very fast & can handle large amount of information at one time. It can perform similar operations thousands of times, without becoming bored, tired or careless unlike a human being

Speed: A computer processes information at extremely [illegible] speeds, [illegible] of times faster than human beings.

Flexibility: General purpose computers may be programmed to solve many types of problems.

Accuracy: *Computers may be programmed to calculate answers* with a desired level of accuracy as specified by the programmer.

Intuition: A computer has no intuition. A man may suddenly find the answers to a problem without working out the details but the computer can only proceed as ordered.

Brain VS Computer: The computer of course, can't replace the human brain. It can't decide at its own what needs to be done and how it's to be done. It can only do what you tell it to do. It also can't do what you meant to tell it or what you think you had told it. It can't understand the hidden meanings. If there is any logical error, that is, an error in your reasoning, the computer will produce wrong result, wrong from your point of view but right from computer's point of view. Thus, one has to tell the computer very precisely about what is has to do.

Table 4.1

Human Brain V/S Computer

Parameter	Brain	CPU
Weight	About 1.5. kg	Few grams to many qntls
Energy source	*Glucose/fructose*	*Electric power, micros need* very less power
Temperature	More or less steady temp. required	Can tolerate large range
No. of cells (for computation)	About one hundred billion	about one billion but increasing with further developments.
Type of memory	Long term, short term, can't be washed	ROM, RAM. The ROM is permanent but RAM is washable just by putting off power
Placement of different parts	Every part must stay together	may be kept at different places & connected by wires, network, satellite etc.
Retrieval of stored information	Almost immediate	varies from device to device (in milliseconds to minutes)

Accuracy of retrieved information	Inaccurate	Accurate
Accuracy of work	makes mistakes	virtually no mistakes
Primary storage capacity	appx 10 x 10^{12} bytes	appx. 10^6 bytes but increasing with further developments Super computer have even higher than brain
Follow instructions consistently	Imperfect	Perfect
Ability to process for long periods	Poor	Very good
Learning by trial & error	Good	Presently lacking but AI would make possible
Intelligence/ Innovation	In-built	'Stupid'. Presently lacking but fifth generation computers would have 'Artificial Intelligence'
Repairs	Self reparing capability	Easy repair, replacement & amendment
Signal transmission speed	60 m/Sec or 0.04 million instructions per sec.	extremely high $20x10^6$ m/sec or $125x10^1$ MI/sec.
Pulse duration	0.1 sec.	1 microsecond
Density of data package	appx.10000 times more dense than computer	extremely low density but transmission rate much higher than brain
Execution speed	Slow	Very fast

UNITS OF A COMPUTER SYSTEM

A computer processes information. Technically speaking executes programmes.

To do anything fruitful, it has to have four basic elements:

1. The Central Processing Unit (CPU).
2. The input.
3. The output
4. The power supply.

The Central Processing Unit has three parts technically known as:
(i) The Control Unit.
(ii) The Arithmatic & logic unit &
(iii) The memory.

To understand the working of each unit we shall compare a computer with a human being

A computer is a 'human being' in the sense that it has almost similar five basic functioning units as a human being has.

Computer	**Human**
Input	Eye
Output	Voice
Memory	Brain Memory
AL	Brain
Control	Central nervous system

CPU: The heart of any computer system is the CPU or central processing unit. That is where all the actual computing takes place.

Input: Humans have input systems such as eyes, ears, and a sense of touch that gives them information about their surroundings. Computers also have input systems. They get information from the keyboard, from the cassette recorder & various other devices known as input devices.

Output: Humans can also communicate (output) with the world in many ways. They communicate orally and by writing. A computer can also output information. They suply information to the video display, the printer, the cassette recorder etc.

Power Supply: The CPU & other units get their operating power from the power supply.

Memory: Like humans, the computer also must have memory. Computers, in fact, have two types of memories RAM & ROM which we shall discuss seperately.

Some computer-systems have many more elements. Joystick inputs, for example, are almost universal on inexpensive computers. Disk drives often complement or replace the cassette recorder in more expensive models.

Computer proper & System

A computer proper has the following units·

(1) A Central Processing Unit (CPU) that executes th programs

(2) The main memory unit that stores these programs and t data for the CPU

(3) Input output ports or interfaces which are needed communicate with the peripherals like TV, printer etc.

(4) Power supply that powers the computer.

A 'computer system' includes the 'computer proper', peripheral devices for input, output and mass storage and also, other special devices, if any, used with the computer.

A typical computer system is shown in the block diagram The computer proper has been enclosed in dotted lines. (Fig 4.1)

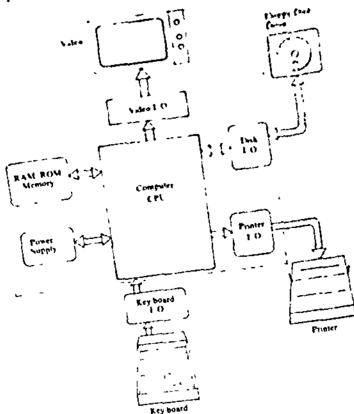


Fig 4.1 Computer System

All computers from whichever manufacturer, & whatever size, the first three basic functional units. Normally the first three are packed together by manufacturers and sold as one unit.

The way these units are packed may vary from computer to computer but each unit is an integral part of any computer system & is always included. For example, small business computers often have the memory, the CPU, and the disk units in a single enclosure, while home computers have the memory, the CPU and the keyboard in a single enclosure.

Some people particularly home computer users don't need a printer and therefore, it's normally not supplied with the computer. However, if you need, you can buy it extra. A monitor (TV or CRT) and a disk drive are essential to use a computer practically. Therefore, they are not optional and are provided with the computer & included in the cost of the computer.

Computer Terms

We would define a few basic terms necessary to understand the operation of a computer. The terms like computer, hardware, software, peripherals, monitor, memory, data, files, mass storage device, CRT terminal, operating system, printer, cassette record, & so on may appear quite technical, but as you would soon see, they are not difficult to grasp.

The CPU: The Central Processing Unit is the heart of the system

It consists of a high speed memory & arithmatic unit for doing the calculation.

It executes the programs. It is generally placed on one single board or part of the board in a small computer. It has a processor & some timing circuits.

Processing: Processing is what computers do Like food processors process food, computers process information. Information goes through one end, gets processed & comes out from the other end.

Hardware: Hardware is the physical part of the computer system & it includes all physical parts like the CPU, memory units. I/O, printer, display unit, storage devices like cassette, floppy drive, hard disk drive, power supply, etc.

When we use the word 'computer' we normally mean the hardware part of the 'computer'.

Software: The Hardware i.e. the computer proper & its accessories form only half a computer system. So that the computer can do something useful, it has to be given a set of instructions. These

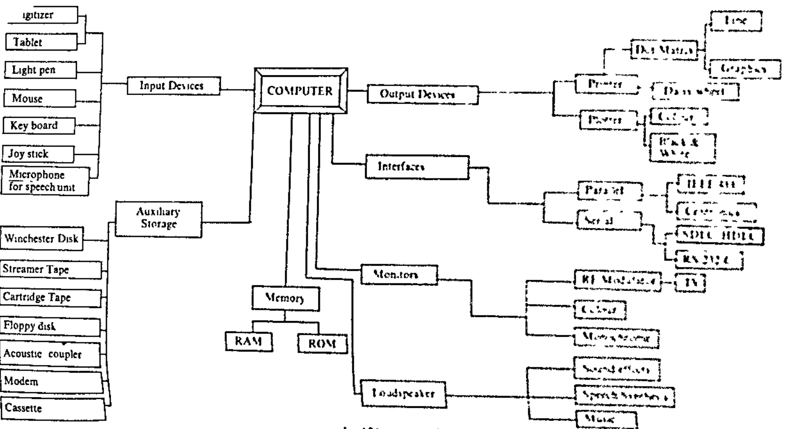


Fig. 4.2 Computer and Devices

instructions are called programs or software. They are the nuts & bolts of the computer system.

Hardware VS Software: Hardware is the actual machine, software (or program) is a set of instructions to run the hardware. It's like a car & the driver. The car is the hardware & includes steering wheel, tyres, the body etc. The driver is the software who actually runs the car.

Software is the programs which enable the hardware to meet specific applications such as word processing, accounts etc.

Both depend on each other. Each is useless without the other. How well a program would be executed is dependent on both software & hardware.

A computer may be compared with a well equipped kitchen which has a stove, the vegetables, the foodgrains, etc. If you want to cook anything, you would have to know how to do it? How to manipulate the items available to produce something worth eating? A 'recipe' is what you need. This is a step by step guide (a program) for how to cook. If a computer is a kitchen, the software is the 'recipe'. As there are different types of recipes, there are different software programs.

Data: Data are numbers & text. Your 'bio-data' is some information about yourself like name, age, qualification, experience, etc. which has numbers & alphabetical characters (text) both. Computer Data is also information consisting of numbers & text.

File: A file is a collection of information that has a name, & is useful as a unit.

A file by the name 'Sheela' may contain Sheela's bio-data. Another file 'Shanky' may contain Shanky's bio-data.

Both programs & data are stored as 'files', on magnetic storage devices like tapes, cassettes, or disk, like the bio-data files may be stored in a filing-cabinet or a drawer or a cupboard.

Program: Before using a computer, one requires proper study of the problem he wants to solve. He has to convert the problem into a set of instructions to be given to the computer, as to how it should proceed. Programs are set of instructions telling the computer what to do when. The process of preparing the instructions is called programming & the complete set of instructions is called a program or software.

Like phonograms 'play' records, computers 'run' programs Programs are also known as software The words programs, packages, software are used interchangeably.

Disk Operating System: Both programs and data are generally stored on tape or disk. A computer has no way of knowing how to store information on a disk. The program that tells the computer how to do this is called a disk operating system (DOS).

Loading the Program: To execute a program, it has to be transferred from the storage device like tape disk or cassette to the memory of the computer. This process is called as 'loading the program'.

One does not have to 'write' in order to 'use' programs, like one doesn't need to know the inside machinery of a car in order to drive it.

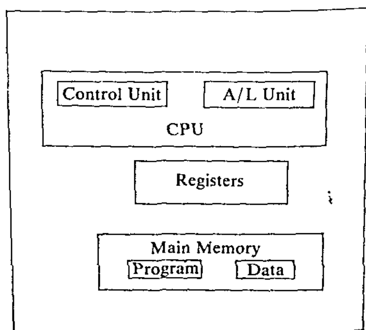


Fig.4.3— The Computer

Data, Instruction, Program, Execution:

Supposing you are capable of doing mathematical additions and subtraction and I ask you to 'perform'. The two questions you ould immediately ask are.

1. What is to be performed, addition or subtraction?
2. On which number has it to be done ?

So, I have to supply you say the numbers 2 & 4, & also I have to specify what is to be done with these numbers; say addition.

Question	Answer	Computer terminology
What is to be performed?	*Addition*	*Instruction*
On 'what' has it to be performed?	on 2 & 4	data

The computer 'asks' exactly similar questions whenever you ask it to do a thing. In computer terminology the first part is called an 'instruction' and the second part as 'data'.

Now suppose I ask you to perform

2+4 — 3+7+4 — 9

You would be probably doing it in following steps:

Step 1 2+4 = 6
Step 2 6 — 3 = 3
Step 3 3+7 = 10
Step 4 10+4 = 14
Step 5 14 — 9 = 5

The result after 5 operations is 5

A computer also goes step by step You 'know' what steps you have to take but the computer has to be precisely told about each and every step or instruction.

The group of such instructions is called a 'program'. It's a collection of all the instructions which enable a computer to do something fruitful. Of course, you have to provide 'data' to the computer on which this 'program' would be 'executed'.

'Execution' of programs is what computers do.

Bit: The smallest unit of information a computer can manage is called a bit. A bit in our terminology is either a '0' or a '1'.

Information in the computer is stored as electrical charges in what are known as 'memory' cells. A cell is a tiny section on a silicon wafer which is charged by an electrical impulse. Each cell stores one bit,i.e., either '0' or '1'. The presence of charge indicates '1' & absence '0'

Byte: A byte is the amount of memory needed to store a character such as 'p' or '4' or '*' etc. Generally 8 bits are combined together to form a byte.

Please note that the word byte is *spelled with a* 'Y' to distinguish from bit & bite.

Most computers have their memories organised into bytes, that is they deal with groups of bits and not a single bit. Each byte of memory can store one character or number.

Kilobyte: Even a smallest computer can process a lot of bytes, the normal unit of computer memory is called a kilobyte. A kilobyte is 1024 bytes and is written in short as 'K'.

If someone says that a computer has 8K of memory, it means that it has a memory of 8 times 1024 i.e. 8192 bytes.

To have an idea of the scale of a typical computer's memory, a typical foolscape page, typed in double space, can have about 2000 characters on it, so, an 8K computer can store about 4 full pages. That is quite a small amount for computers & that's why most computers have at least 32K of memory, sufficient to hold about 16 pages of information.

Megabyte: Bigger computers have memories in thousands of Kilobytes and their memories are represented in megabytes. One megabyte is 1024 kilobytes or 1024 x 1024 i e. 1,05,376 bytes & represented as 1 MB

In a computer system, K means 1024. However, in practice, it is taken as a round thousand and the convention is accepted by all. Thus, a 256 K computer actually having 256 x 1024 i.e. 262, 144 bytes of memory is mentioned as having 256 x 1000 bytes memory. Similarly one megabyte is known as 1000K amounting to about one million characters, instead of exact 1024 x 1024 bytes

Word Length: The number of bits grouped together & used as a unit for operations in a computer is known as the computer's word size.

The more powerful and quicker the CPU, the more the bits it can manage simultaneously.

Typical word sizes are 8, 16 or 32 bits. Note that since generally 8 bits are used to represent a character, a computer having 16-bit word length can process two characters (or bytes) simultaneously.

Codes

Computer needs memory and storage since the instructions to the computer have to be stored somewhere. Data to be processed is also to be stored.

As we have seen, computers have their memories organised into bytes, a byte generally being a group of 8-bits. Since each bit has two possible values 0 & 1, the combination of 8 bits can have 2^8, i.e. 256 possible values. Computers treat each such value as a code which may stand for an alphabet or a number or a punctuation mark or an instruction or any special symbol. Thus, a letter 'T' is not dealt by the computer as T but the combinations of bits assigned by us for representing T, i.e. the code for T.

There are number of codes used to represent alphabets, numbers, symbols, etc. (Fig 4 4).

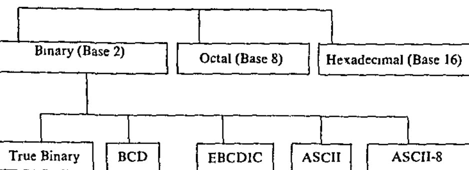


Fig. 4 4 COMPUTER NUMBER SYSTEMS

Computer Languages

Computers can't understand our day to day languages like English, Hindi, French, etc. Unfortunately, not many of us can understand computer's language unless we are experts. If we want our problems to be solved, we must somehow 'converse' with the computer & vice-versa. To overcome this problem some via media in the form of intermediate languages have been developed. They bridge the 'communication gap' between us & the computers. These languages tell the computer what we mean, and tell us what a computer means These translators are of various degrees in that

they vary in their translating capabilities. Technically they are categorised as:

1. Machine language.
2. Assembly language.
3. High level language.

The instructions written in machine & assembly languages are easy for the computers to follow but very difficult for people Earlier, the computers could be programmed only in these two languages which required sophisticated training & thus, only experts could use a computer. However, high level languages are English like & easy to follow. So, the programming is very easy now.

The Memory

The memory is used to store information consisting of programs & data. It is made up of number of what are known as LSI chips (Large Scale Integration Chips). Each memory chip can store thousands of bits of information.

A typical business computer has minimum 64K bytes memory which it places on one or more boards.

Chips are affected by heat & can malfunction when temperature rises.

CPU Memory VS Secondary Memory

The CPU memory & the memory on the secondary device like a disk are very different. The CPU memory is temporary in the sense that information is stored in the CPU only when one is working on it. When the work is over, or the computer power supply is put off, the information stored in the CPU is lost. On the contrary, the information stored on a disk remains on it indefinitely, unless the computer is instructed to delete it from the disk.

A human being, if he doesn't have memory, can't remember a thing. Likewise a CPU also can't remember a thing. As soon as something is processed, it's forgotten. So some form of memory is needed. Computers have two types of memory.

ROM—Read Only Memory

The CPU can take information from ROM ('read' it) but [illegible] information to it ('write' on it). It is programmed by the

Computer manufacturers & can't be changed by user. ROM retains its memory irrespective of power, whether on or off.

RAM—Random Access Memory

The CPU can read from RAM & also write into RAM at will. It can erase something in RAM & then write something else. It is also known as user programmable memory since user has access to it. Once power is turned off, RAM forgets everything.

For storing the processed information permanently, the computers use disks which are either floppy or hard.

Floppy Disks are circles of plastic (mylar) coated with iron oxide, the same material used in tape recorders. The disk's normal size is 5¼". They are covered with a square, protective card envelope The entire envelop goes into the disk drive.

Disk Drives spin the disks, like a turntable spins a phonograph record. Disk drives have read/write heads which read information from the disk & write information onto the disk.

One floppy can hold 81KB to 1200KB information i.e. about 20 to 300 pages of single spaced typewritten text. A file containing about 200 pages can thus easily be put on a floppy.

To store information greater than 1200K we require a hard-disk. It is a solid platter of plastic or metal into which iron oxide is bonded. It can hold 5 to 20MB & larger capacities are also available. Not only do hard disks hold more information, they also read & write information faster than floppy disks

Disks are used not only for storing information contained in RAM, but for putting information into RAM as well. This is in the form of programs & data.

Memory Unit: The memory unit of a computer has a number of storage locations, each location known by a unique number called its 'address'. The memory unit of a computer can be comparedto post office. Different letters can be placed in a postal box, but the box number is always the same. Likewise different data may be stored in any given storage location but the address is the same.

The data that are to be stored in the memory are described by the 'program' and the particular storage locations where the data is to be stored is also described by the 'program' when it's loaded into the computer memory.

Floppy Disks

Floppy disk or a diskette is a low-cost storage medium Floppy disk drives are generally used in pairs (so that the contents of one disk can be easily copied to another).

Floppy disk is a fourth generation innovation. The storage capacity and access speed are much less than hard disks but much high compared to cassettes. Also Floppy disks are less expensive, easier to manoeuvre and quite suitable for microcomputers.

Like the needle of a gramophone record can be lifted to any point, floppies can be accessed randomly at any point, the access time being only a fraction of a second. A floppy can store upto 1.2 MB i.e. 1,200,000 characters data depending on the floppy drive and the capacity of the floppy disk. However, for large business applications, their storage capacity is too small and their access speeds too slow. For such applications, hard disks are used. Due to their low cost, the floppies are most commonly used devices for small computers.

Hard Disks

They are more expensive than floppy disks, but have high speed and a huge storage capacity. The smallest hard disk drive available today can store five million characters (5 MB). Some computers such as the IBM-PC-XT have hard disks built-in with storage capacity of 10 MB. Many others allow you to add a hard disk drive to your micro by plugging in the disk-drive into a disk-drive-interface in the computer.

I/O DEVICES, PERIPHERALS, ON/OFF-LINE DEVICES AND COMPUTER SYSTEMS,

The terms, I/O devices, peripherals, off line devices, on-line devices, computer system, etc. are often used by a computer user. Some of them are sometimes used loosely & interchangeably. Let us try to understand them clearly. (Fig 4.5)

I/O devices: These are the devices used to input/output data to & from the CPU. The input/output is easily understandable since it consists of the symbols used by us in daily life. The examples are typewriter, video display, printer, card-punch unit, etc.

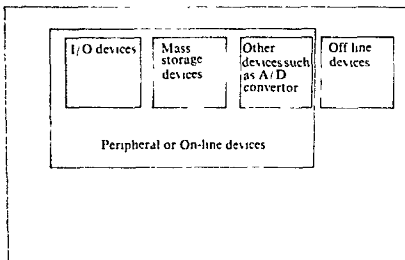


Fig 4 5 Complete Computer System

Mass Storage Devices: Strictly speaking, the devices like cassettes, tapes, disks etc. are not included in I/O devices, since their input/output is not readable except when used with I/O devices. They are called mass storage devices. These devices are quite fast compared to the I/O devices.

Peripherals: These are devices which are connected to the CPU but are not part of the CPU They include both I/O devices & mass storage devices. They also include devices such as Analog-to-Digital (A/D) converter etc.

On-Line Devices: The devices discussed so far, like I/O devices, mass storage devices & other devices like A/D converter, together are called on-line devices since all of them can be used or directly connected to the CPU when the computer is running a program Please note that 'peripherals' & 'on-line', are thus, synonymous terms.

Off Line Devices: In addition there are auxiliary devices like keypunches, card sorters etc. which are not directly connected to the CPU. These are called off line devices.

Computer System: The combination of all on-line & off-line devices is called a computer system.

INPUT OUTPUT PORTS

A port is a gate for entering into the computer. Information flows into the computer through an input and flows out from the computer through an output port. A port, irrespective of

which function it permits, whether inputting or outputting the data, is simply known as input/output or I/O port.

These ports are made up of some electronic circuits. From one side they are already connected to the computer and are often built-in with the computer, the other side has a plug or connection to connect it to another device such as a printer, a TV, a disk-drive, a cassette recorder, etc.

The input/output (I/O) devices, also known as peripherals, connect the computer to the outside world. The word peripheral signifies that these devices are built around i.e. on the periphery of the CPU They cost extra, in fact, they constitute a major portion of the total cost of a computer system. Physically also, they are bulky

These devices are used to store data, to enter data in the computer or to output data from a computer. Many of them would therefore, fall in one of these three categories:

1. Data entry devices such as keyboard.
2. Data storage devices such as floppy disk-drives.
3. Data output devices such as video, printer, plotter etc.

The input/output portion of the computer manages transfers of information, say from an input device such as keyboard to an output device such as a printer.

Many types of I/O devices and accessories are available for a computer. Various peripherals like printers, video displays, interfaces, plotters, graphics, tablets, joysticks, game paddles, etc., are generally available. Some computers even permit speech recognition, speech synthesis, music synthesis, high quality graphics, extra memory boards, different disk drives, etc.

Many buyers of small computers today have the component approach. They buy computer as a separate unit and then pick and choose from a wide variety of accessories to complete the computer system. The advantage of this approach is that you can have accessories of your choice.

Keyboard: The keyboard of a computer looks & acts like a typewriter keyboard. The characters typed appear on video screen. The keyboard is also for giving commands to the computer. These will not appear as standard characters on the screen, but will some part of the program to perform specific tasks. Like 'delete' would 'wipe-out' a character from the screen.

CRT-Terminal: It is standard peripheral that includes a keyboard & a TV-like (video) display.

A small computer has one terminal while a large computer will have many terminals all connected to the same CPU. The terminals used with small or large computers are generally similar. Each has a typewriter like keyboard (with some additional special keys), & a video-display.

The video screen on a computer is for CPU to display information recorded in RAM, ROM or on disks. It also displays information added by user from the keyboard.

The screen displays a 'cursor' which is a flashing square or line, one character wide, that indicates user's position on the screen.

Printer: A printer prints letters, graphs, charts, reports, etc. Several types of printers are available with computer.

A letter quality printer prints fully formed characters like a typewriter. They cost more than another type of printers known as dot-matrix printers-which print faster & can also do graphics.

TABLE 4.2

Hard & Non-Hard Copy devices

	Hard Copy	Non-Hard Copy
Input	Cards Paper tape Optical scanner	Keyboard Light Pen Tablet Mouse
Output	Printer Microfiche Plotter	CRT (text & graphics)

Cassette I/O: Microcomputers generally have a built-in cassette I/O. Cassette is the cheapest method of storing computer infor-

mation. Cassette tape needs tape recorder for recording & recalling of information from & onto the tape. The information to be recorded is first converted by cassette system from ASCII bits & bytes into tones which are stored on the tape. Whenever the computer requires this data, the process is reversed & the tones are converted into ASCII bits & bytes.

Disk I/O: Cassette tapes are slow & sometimes unreliable. The computer information is therefore, normally stored on floppy or hard disks which are fast & more reliable.

A system called disk-controller is required to send data to and from disk drives. Some computers have this system inside the computer enclosure itself. Other computers have a separate disk-drive which contains the disk-controller & other circuitary. The computer having a separate disk-controller does not use part of its RAM to store the disk operating system (DOS).

Sound I/O: Ealier computers did not produce any sounds other than a couple of beeps. The new models can generate all sorts of sounds.

Joy stick, Light pen, Mouse, Game paddle, I/O ports: These are special versions of generally a parallel I/O port, designed specially for a device. Computers having ports for such devices are more versatile than the ones not having them.

Speech Synthesis: Do you want to talk to your computer? well, it is possible.

All you need is a speech synthesizer with your computer which can recognize the words and commands given by you. The speech synthesizer is basically a speech recognition unit.

Many micros are available with this capability. For instance, a couple of models from Atari computers have a built in speech synthesizer. Texas Instruments offer an optional speech synthesizer with their model TI-99/4A.

Computer Music: Most of the micros have no built-in sound generation system. Some can generate crude buzzersand a couple f beeps. There are micros, however, which have built-in sound esizers to create music and large veriety of sophisticated s in many voices.

Computer sound synthesis can be explained in three ways:

1 Number of Voices— It refers to the number of separate sounds the computer can generate simultaneously. A five-voice system for example can generate five sounds together.
2 Octave range— It refers to the ranges of sounds the computer can make.
3 Envelope control— It refers to how much control the computer permits you over the generation of sound (e.g. pure tone, complex tone etc.)

A one-voice synthesizer can control and generate one sound at a time while a two-voice system can independently control two sounds. Very simple synthesizers can control only the pitch of the sound & duration, the advanced ones can control the waveform also so that you can create all types of sound effects and electronic music.

Generally, the built in sound features on micros are not very sophisticated. If your primary need is computer music, add-ons for different computers are available. You can buy one and plug with your micro for sophisticated music.

The Commodore-64 personal computer has a very sophisticated synthesizer. A piano style keyboard is available as an accessory which can fit with the micro with the help of many programs available for this micro. One can play the piano as one plays an electronic piano. Apple II is also popular with computer music lovers since a number of companies supply synthesizers and keyboards for it.

Interfaces: The input/output *interfaces are used for interaction* between the peripherals and the computer. Each interface is normally placed on a separate board. For instance, a video controller board is put in the computer for interfacing between the CPU and the display unit. A printer requires a separate controller board which also is provided inside the computer.

Parallel & Serial Port: Two kinds of I/O ports are used They are called parallel and serial.

Parallel: Parallel port can receive and send all the bits in a byte together. It has a separate connection for each of the bit.

If the computer sends a byte to the printer through parallel port, all eight bits in a byte are together sent by the port to the

TABLE 4.3

Peripheral & Mass Storage Devices

Device	Function	Medium	Type	Speed/Rate of data transfer	Capacity (MB)	Remarks
Card reader	input	punched card		200-2000 cards/min	each card about 80 characters	
Card punch	output	punched card		100-500 cards/min	each card about 80 characters	
Paper tape reader	input	punched paper tape		200-2000 characters/sec		
Paper tape punch	output	punched paper tape		30-300 characters/sec		
Magnetic ink reader	*input*	*magnetic ink*		750-2000 documents/min	each document about 15-30 characters	
Optical scanner	input	paper		100-3000 documents/min		
Typewriter terminal	input/output	paper		6-30 characters/min		
CRT Terminal	input/output	CRT		250-10000 characters/min		
Dot matrix printer	output	paper		100-1000 characters/min		
Daisy wheel printer	output	paper		10-50 characters/sec		
Line printer	output	paper		300-3000 lines/min		line by line printing

Magnetic drum	storage	magnetic drum	direct access	275-1500 characters/sec	1-12	access time 6-25 msec
Magnetic disk (head movable)	storage	magnetic disk	direct access	100-800 thousand characters/sec	2-200	access time 20-80 sec
Magnetic disk (fixed head)	storage	magnetic disk	direct access	150-2000 thousand characters/sec	6-600	access time 10-50 sec
Floppy disk	storage	magnetic disk	direct access	50-500 thousand characters/sec	0 1-1 2	
Magnetic strip handler	storage	magnetic strip	direct access	25-45 thousand characters/sec	100-400	
Magnetic tape reel	storage	magnetic tape	sequential	15-800 thousand characters/sec	1-20	

printer over 8 different lines. Generally, the input from the keyboard to the computer and output from computer to the printer are through parallel ports.

Centronics parallel or centronics compatible port is a industry standard parallel port. If a computer has a centronics parallel port and the printer has a parallel interface they can be connected to each other

Serial: In case of a serial port, when 8 bits of data arrive at the port, they are sent to a peripheral bit by bit i.e. one bit after another on the same single line. The bits in each byte go out of the computer or come into the computer over the same line, one at a time.

Data transmission over telephone lines is normally done by using serial port.

RS-232 (also known as RS-232 C) is used with serial ports If a printer has a serial interface (or a telephone coupler is RS-232 compatible) and the computer has a RS-232 serial port, the printer (or the coupler) may be connected to the computer.

Interface boards reside within the computer enclosure to reduce communication delays between the interfaces and the CPU Often, they are plugged directly into the 'motherboard' (the main board) of the computer. Alternatively, a separate rack is provided within the computer which contains all female connectors to which the peripherals may be connected by male connectors. The interconnection path of the interface boards inside the computer is known as 'internal bus.'

Many computers have standard serial and parallel interfaces for connecting a printer & a CRT appropriate to the computer. If these interfaces are not provided, one would have to buy separate serial/parallel communication board at extra cost to connect to a printer. If your computer doesn't have the I/O capacity you need, the experts in the computer field can help you in increasing the capacity economically.

Baud Rate: The rate at which data is transferred. Measured in bits per second (bps or baud), it's often used in relation to serial ports. To have an idea in terms of words per minute, to which we are more accustomed, a baud rate of 400 is 400 x 60 or 24000 bits minute, or 3000 bytes per minute (8 bits to a byte), or 500

words/minute (average 6 bytes to a word). Telephone couplers (modems) generally work at 300 baud i.e. about 350 words per minute. A human being speaks about 100-400 words per minute.

The power Supply

The CPU, the memory, the peripherals, the interfaces, etc, all need power for their working. A small computer normally incorporates a power supply that delivers the required voltages to the boards.

Power Supplies for Small Computers: Till recently the power supplies for small computers were very heavy. Memory chips consumed great power in the early micros. By now, the memory technology is so advanced that micros need very little power as a result of which, small and inexpensive power supplies have been designed for micros.

The inexpensive micros have a built-in power supply only for the computer itself. The accessories have to be supplied power seperately, generally a seperate power supply for each accessory. The expensive micros, however, have built in power supplies for computers as well as other components.

Most micros require two voltages, +5 & +12, some others use —5 & —12. The power supplies designed for micros work on 230 volts AC (what you get from the electricity supply plug) and convert it into DC voltages required by the micro.

Quality of Power: The quality of the power supply is very important for reliable computer operation. The computer needs clean power for its proper functioning. The main cause of disruption or malfunctioning of a computer is due to electrical pollution or noise coming in through the power line.

So, while installing a computer, a thorough check of the line voltage level must be made. If required, an uninterrupted power supply (UPS), a line regulator or a line isolator should be used.

Generally, the power supply has built in filters to maintain voltage at certain level only, say +5 or +12. The supply which does not have this facility would have fluctuations (what are technically known as 'ripples') in their output i.e., the voltage level would go slightly up and down from the fixed required level. Say for +5 volts, it may vary from 4.5 volts to 5.5 volts, the

fluctuations being ± 0.5V. Micros are generally very sensitive to ripples which may cause malfunctioning or erratic behaviours of the micros,so a power supply for a micro must have good filters in it

All electricity cables and wires should be fixed in the wall and they should be so laid out that the electromagnetic interferences are eliminated. In fact, all visible and obvious sources of electromagnetic interferences should be removed from the computer room and its neighbourhood. For instance, fan, air-conditioner, photocopier etc. should not be put in the same circuit as the computer.

5.

Binary System

In our daily life, we normally use decimal number system in which digits go from zero to nine, with a total of 10 digits (0, 1, 2,...,9). Computers may be called 'stupid' since they can't understand decimal systems. They use a number system in which only two digits 'O' & '1' are possible & we have to translate all our problems into various permutations & combinations of these two digits & then only we can think of getting them solved with the help of a computer.

Every daily life character whether an alphabet, a number, a punctuation mark, a special symbol, a dot in the picture, every thing had to be converted into combinations of 0s & 1s before it can be sent to the computer & computer can really work upon them. The two digits 'O' & '1' are called bits. The word bit stands for 'binary digit' In fact 'b' of binary & 'it' of 'digit' have been combined to form 'bit'. A symbol is generally represented as a combination of 8-bits & is called a byte.

The number system using only Os & 1s is called a Binary system. It is unlike the decimal system in which digits go from 0 to 9.

One naturally gets curious & may have two questions about this system.

1. Why has computer taken up to this kind of system?
2. Why a 2-bit system? Why not less than two (say one) or more than two (say four) bit system?

The reason for the first choice is that the system can be physically represented in the most easy way & can be most easily understood by a computer. The two possibilities 'O' & '1' can be easily represented electronically. For instance, presence of a pulse of electricity may represent '1', the absence as 'O'

The two digits 'O' & '1' are in fact the two only possible states or choices for a number of phenomenon. Like the presence of a

pulse of electricity is understood by a computer as '1' & absence as '0', the presence of a magnetic field is read as '1' & absence as '0'. Other examples in daily life are shown in table. So '0' & '1' can simply be understood as 'off' & 'on', or 'yes' or 'no', or 'black' & 'white', & so on.

The electric pulses or magnetic fields are known as bits The presence of a pulse is a '1' bit, absence a '0' bit.

System	State '1'	State '0'
Binary	1	0
Voltage pulse	pulse	no pulse
Bulb	ON	OFF
Switch or Relay	closed	open
Tap	ON	OFF
Megnetic Core	polarised	reverse polarised
Logic	'Yes'	'No'
Telephone	Ringing	No ringing

Fig 5.1 Binary State representation

The next question — Why a two bit system? Why not one bit only which is even simpler compared to two bit system.

The answer is that we need a minimum of two items to represent everything on earth. Just one item won't do. Permutation & combination is possible with at least two 'separate' items, not with just one.

What is interesting to note is that just two items are sufficient represent anything & everything as we shall soon see. We say 2 items, or digits, or bits, or we give whatever name to it, are

necessary & sufficient to represent all the information. So, there is no need to go for a higher bit say 3-bit or 4-bit system.

Can you think of other systems we use in daily life with base other than 10? What about hours, minutes, seconds? The base is 60 for converting seconds into minutes & minutes into hrs. What about yards, feet, inches? The base is 12 for converting from inches to feet. Similarly we can think of dozens, days, weeks, miles, & so on. (Though, the digits are still from 0 to 9, only the bases are other than 10, other than what it is in decimal system).

TABLE 5·1

Comparison of Octal & Hexadecimal Number Systems

	Octal	Hexadecimal
Length of word	Long	Short
Convenience	More convenient when word length divisible by 3	More convenient when word length divisible by 4
Deviation from binary	Easier	Difficult
Conversion to decimal	Easier	Difficult to convert since characters & digits both are to be remembered
Ease of understanding	Easier, since all characters are numbers	Confusion possible since letters are also combined with digits
Arithmetic	Simple	Difficult

No need to learn the Binary system

The greatest convenience with a computer is that we can still work with decimal system of our daily life, instead of learning the binary system. We can feed the information as letters & characters & numbers known to us through a keyboard, which will automatically convert them into binary system. If the computer also has what is called a video screen, which is just like a T.V., the information appears on the screen also, which

characters well known to us. One does not have to know the binary system to use a computer.

By supplying information or command via the input device such as keyboard & receiving information via the output device such as a video, the user can have a dialogue with the program. Generally the user types at the keyboard while looking at the videoscreen

6.

Microprocessors & Processors

Processor: The heart of any computer system is a Central Processing Unit (CPU) and the heart of the CPU is the chip called 'Processor'. The processor is that part of a computer that fetches, decodes and executes 'Program Instructions'. It contains the control, calculating and decision making parts of the computer so that the processor, although small, is really the driver of the computer. It decides the power and performance of the computer system The CPU is therefore, the most important element in the computer

Microprocessor: Microprocessor also called 'Microprocessor Unit' (MPU) is a single tiny device that performs the functions of the CPU. Microprocessor and chip mean the same, and refer to the small piece of silicon having the complex electronic circuitry. What is important to note is that Microprocessor is a single chip which contains calculating, decoding and decision making part of a computer. The tiny chip which is made from silicon has thousands of electronic parts on it like transistors, capacitors, resistors, and is called an 'Integrated Circuit' (IC) chip. The specialities of a microporcessor therefore, are that it is programmable, it is on a single tiny chip, and it has no moving parts

Appearance: A typical microprocessor is about 2" long and ½" wide, as one would buy it from the market. The actual microprocessor is, however, much smaller, only a couple of millimetres in size and occupies the small area beneath the square shown in the figure. Most of the part of a microprocessor is occupied by a protective plastic. A tiny silicon chip which does all the wonder is sealed inside the plastic covering. The silicon chip is extemely small, even smaller then the size of a finger nail.

Packaging: Most of the size of microprocessor comes from its plastic packaging which is called ' dual-in-line-package' (DIP). Two sets of leg like pins can be seen which plug into a socket and connect the microprocessor to the rest of the computer system. A chip may have 40 to 64 pins.

Though the microprocessors may look alike from the
but different types have different operating characteristics.

are used for a single specific purpose like running a digital watch This kind of microprocessor has some memory written on the same chip to store programs for their own use.

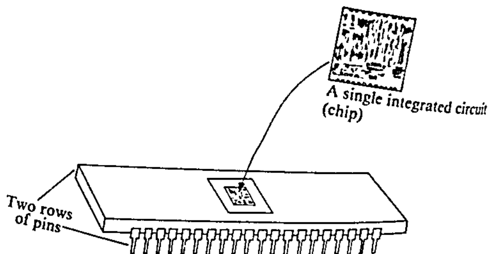


Fig. 6.1 A 40-pin microprocessor

Processors are generally not made by the microcomputer manufacturers. They are bought from third party companies which supply to the whole computer industry.

In India the processors and many other main components of a computer are imported or bought in off-the-shelf from third parties, by the so called manufacturers. Therefore, most computer 'manufacturers' can better be described as 'assemblers'!

Microcomputer & Personal Computer: Microprocessor, though a very powerful computer device, is not of much use by itself Just as a human brain needs hands, feet, eyes, nose, mouth etc. to do some physical actions, a microprocessor needs to be connected to other devices. A microprocessor connected with the devices needed for doing a certain job is called a 'Microprocessor System'.

Microcomputer refers to a small personal, business, or technical computer built around a microprocessor chip. A microcomputer is more than a microprocessor system in the sense that Microcomputer has all the parts of a computer. For its calculating and decision making parts it has a microprocessor. It also has put, output, memory & a few wires. Thus, a microcomputer is a

microprocessor plus input plus output plus memory and plus a few wires.

Computer = Input/Output+Microprocessor+Memory

DEVELOPMENT: Dr. Marcian E. Ted Hoff Jr. who conveived the idea of microprocessor realised that the architectural principles used to make large computers can be applied on a very small scale to produce microcomputer based on microprocessor.

As mentioned earlier, the production of microprocessors could be possible because of the technology of 'Large Scale Integration' (LSI) and later technology of 'Very Large Scale Integration' (VLSI). Thousands of electronic parts like, transistors, capacitors, resistors can be put onto smaller and smaller chips. A piece of silicon half a centimetre square can contain 100,000 electronic parts. It is interesting to note that the capability to put more and more such electronic parts, on to smaller and smaller pieces, for lesser and lesser money is increasing every year It is very difficult to predict the final implication of this 'micro-miniaturization' on our future life.

It is because of microprocessors, their miniature size, fast speed, higher reliability and still low prices that has made possible a whole new class of computers known as 'Personal Computers'. They are same as microcomputers and have become extremely popular and useful.

Today a typical business-oriented microcomputer system can cheaply and easily handle computering application that the largest of mainframe computers, a few year ago, could handle only with difficulty and at great cost. As miniaturization proceeds, the personal computer will become an extremely popular device with application and capabilities not yet fully appreciated.

Without the microprocessor, there would be no micro-computer industry, and without the microcomputer, there would be a very different kind of society emerging than is presently the case. The microprocessor (and IC in general) will be looked upon in the future as the creator of that future.

The main technical difference between 'micros' and others i e. 'Mainframes', 'Minis', etc., is that 'micros' use microprocessor 'chips' and they are very small and cheap Micros provide a 'one to

one' personal interaction between the user and the computer.It is like travelling by car instead of a train. The driver of the car is in total control of the car Likewise, a 'micro' user is in total control of his microcomputer.

With the coming of microprocessor, it has become possible for the first time to bring computers to the finger tips of a general user which was an impossible task with early big computer systems In Europe, the chips have already found their way into stereos, Videos, Cassettes, Automobiles, Microwave ovens, toys and thousands of other everyday items. It is estimated that in the next decade, the number of microcomputers in the home will overtake the number of motor-driven household items.

BUSES

A set of wires is technically called a 'bus' that is used to transmit information among two or more devices. All the three parts of the microcomputer, the memory, the input and the output, need the buses to exchange information.

The microcomputer uses its buses to communicate with the other parts of the system such as the microprocessor, the memory, the storage devices etc There are three kinds of bus systems according to the kind of information they transmit.

1. **The Data Bus:** The data bus transmits data into and out of the microprocessor. By data here, we mean any values stored in memory or to be written into memory. The data bus is bi-directional meaning thereby that data can flow in either direction, from microprocessor to memory or from memory to micro-processor. This reduces circuitry & thus, the cost of the micro-computers

Data is transferred between the microcomputer system and the peripheral devices via I/O port which consists of an I/O port buffer, connected to the various lines on the data bus.

2. **The Address Bus:** It permits the microprocessor to select an individual location in memory to or from which data is to be transferred. The address bus is unidirectional because information goes one way only; from the microprocessor to the memory.

3. **The Control Bus:** The control bus contains control lines from pins of the microprocessor, such as the read/write. A

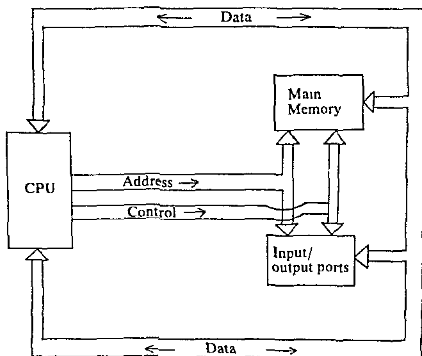


Fig 6.2 THE BUSES OF A MICROCOMPUTER

control bus has many lines as it needs. It is unidirectional, each line of the control bus goes only one way. Some lines, such as Read/write go only out of the microprocessor while others go only into the microprocessor.

Word Length: Microprocessors for microcomputers are normally 8 bit, 8/16 bit, 16 bit, 16/32 bit. 8 bit processors access data from the memory, and operate internally 8 bits at a time; 16 bit processors do so 16 bit at a time & so on. The number of bits a processor can operate upon internally is referred to as the word length.

Microprocessors & Their Speeds

Some chips carry out instructions faster than oth[illegible] They are rated as per their processing speeds Chips can be [illegible] ways, the two primary ways are.

(i) Clock Speed

First way of rating a chip is throu[illegible] speed. Let us not go into the techni[illegible]

processor's clock speed is measured in Mega Hertz (MHz) and that, generally, the higher the clock speed, the faster the processor is able to handle data For instance, Z80A chip is faster than its old version Z80.

It should be noted that the same chip may operate faster in one computer than in another. It is because different models are designed to operate at different speeds even while using the same chip Slower computers use cheaper memories to keep their cost low for light duty applications. Business computers for large scale applications require fast microprocessor.

Till some years ago many chips had clock speeds of about 1-2 MHz. Now-a-days it is common to find nothing less than 4 MHz and some of the new chips operate even up to 12 MHz. The IBM-PC works at 4.77 MHz.

(ii) 8/16 and 32 bit chips

The second way of rating a microprocessor is the amount of information it can handle or 'address' at one time. In the microprocessor world, chips are designated as 4-bit, 8-bit, 8/16-bit, 16-bit, 16/32-bit and 32-bit types. Earlier micros could only process 8 bits of data at a time. Since then, however, the micro industry has developed a lot and is using 16 bit chips, and the next stage is the 32 bit chip which has started appearing in the market.

Chips like Z80 are 8 bit chips & they take data 8 bits at a time. If there is a number consisting of more than 8 bits (say 16 or 32 bit long), a micro with Z80 chip would take only 8 bits of this number, process these 8 bits, then take next 8 bits, process them, and so on. The 8086, being 16 bit, may take and process 16 bits at a time. Thus, 16 bit chip would be processing faster than an 8 bit

The hybrid chip like 8088, which is 8/16 bit, takes data in 8 bit units & stores in the memory as 8 bit units, like the Z80 chip. However, once the data is taken in, it is processed in 16 bit units unlike Z80. Thus, 8088 (8/16 bit) works faster than Z80 (8 bit) but slower than 8086 (16 bit) since 8086 not only processes data in 16 bit units but also receives and stores it in 16 bit units. A still faster chip is 68000 (16/32 bit) which receives and stores data in 16 bit units but processes in 32 bit units.

We should appreciate that there is nothing which the 16 chip do that the 8 bit cannot do. The 8-bit is just slower & uses less

memory. The memory was very expensive a few years back. The 8-bit chip was designed keeping a factor of 16 K of RAM in picture. This was enough that time. However, steady decrease in memory prices has led to the use of higher & higher bit chips so that they can accept more memory. A 16 bit chip today can accept even up to 1Mb RAM & many hundred K of ROM. Given a choice, you should opt for a 16 bit micro than 8 bit or 8/16 bit.

Although none of these ways of rating a chip gives the full picture of how well it performs, they do give a general idea about it.

In general, a 16 bit processor is more powerful than an 8 bit one, a 16/32 bit chip is more powerful than 16 bit and so on. A chip with higher clock speed is better than the one with lower clock speed.

TABLE 6.1

Word & External Data Bus Size of Microprocessors

Micro processor	Addressing space	CPU wordsize	External data bus size	Remarks
8 bit	64K	8 bit	8 lines	
8/16 bit	1 Mb	16 bit	8 lines	Larger word size increases the amount of memory that can be addressed & enables more precise & complex instruction sets
16 bit	8 Mb	16 bit	16 lines	
16/32 bit	16 Mb	32 bit	16 lines	The large word size provides more precise calculations & complex instructions
32 bit	256 Mb	32 bit	32 lines	The large data bus enables faster transfer of data to and from storage

Multiprocessing: A technique employing many microprocessors in a hierarchical (master/slave) arrangement.

Old micros relied on a single CPU to direct all operations by time-sharing, but newer ones employ multiprocessing.

Distributed processing: In this, the complicated jobs are performed by the main processor (the master processor) & small specific tasks by other processor (the slave processor or the coprocessors), which perform the tasks more efficiently & simply. It increases throughput from the system & also a mistake in one part will have a limited effect on the whole system.

Parallel processing: Number of processors go on simultaneously (in parallel). High levels of performance are achieved.

A computer using multiple-processors & executing in parallel gives a very high level of performance.

The 8086 chip is so designed that it permits distributed, parallel, multiprocessing system

Compatibility Mode: Some micros can run programs that were written for other models or other computers by use of compatibility option, such as an interface card inserted in the processor. This option has the advantages.

(i) It increases the number of programs that can be run on the computer.

(ii) It avoids having number of programs that can be run on the computer.

(iii) It avoids having to rewrite programs that are being transferred from another machine.

However, running in compatibility -mode can sometimes reduce processing speed

Power of a Chip

Main considerations that determine the power of a microprocessor:

1. Clock Speed, i.e. How fast it can process data.
2. How wide a data word it can it handle. The wider the word, the greater the throughput of data.
3. Instruction set: How many instructions it can understand The greater the number of instructions, the easier it is to write programs.
4. Memory. How much memory it can address.
5. Interfacing available: Each data word stored in memory has a specific address, and many more addresses are possible with longer data words. However, more important than this would be to check on the microcomputer system performance as a whole by studying the quality of software, system support, documentation etc. available.

Many 8 and 16 bit processors address the memory through 16 address lines This means that the processor can address 2 unique address locations. ie 65,536 bytes of memory

6 Bus: A 16 bit chip has a 16 bit data bus available. The large the registers and bus, the greater the computering power because of

(1) Increased numeric precision (larger numbers)

(2) Greater speed and efficiency (fewer machine cycles required for complete operation)

(3) Greater memory addressing capability (larger, more sophisticated programs).

Microprocessor Speed & Some Factors

(i) A computer may be faster for one type of application than for another type. For example a computer for application involving lot of mathematical calculations may be faster compared to another application requiring lot of Input/ output. Speed of processing depends on the type of application

(ii) **It is very difficult and unreliable to try to calculate how** long a program will take based on the speed of the devices. If speed is very important to your applications, **it is best to carry out a trial run and time it yourself. The** trial is technically called 'benchmark'

(iii) In general, a '16-bit machine' is faster than '8-bit machine'. **But it is not necessarily twice as fast because only the size** of the microprocessor is being referred to and this is only one of the several factors involved. Even when we use a fast 16-bit processor, but use a tape for storage of data, the overall speed of the system will be low because of slow access of data on the tape.

Computer Program & Processing Speed

How fast a particular program can process an application **depends on many factors. The total effective speed of data handling & addressing in the computer is decided by:**

* The volume of data to be read, written from the disk.

* The access and the transfer speed of the mass storage device
* Hard disk is several times faster than floppy disk.
* The speeds at which the I/O devices can receive data.
  The size of the microprocessor chip, 8-bit or 16-bit or 32-bit
  A 16-bit chip transfers data 16-bits at a time & 8-bit chip transfers 8 bits at a time. Thus, 16-bit transmits much more data in the same interval of time.
* Whether there are one or two microprocessors, If the disk I/O is handled by a different chip than the one performing the calculations, the program will take less time.
* The size of the 'buses' that is, the wires that carry the data between the microprocessor, the memory & the storage devices.
* Whether special chips are used· Some micros use specially designed LSI chips to enhance special features of the computer, such as, the graphics, color and the sound. Use of special chips improves the features and speed up operation since the main CPU is freed from the task of generating graphics and sound.

Bit-By-Bit: The micro computer industry owes its start to the Intel corporation which in 1972 with the help of Dr. Hoff developed the first functional microprocessor, the 4004, a 4-bit chip. An 8 bit version, the 8008, soon followed. Neither of these chips carried the microcomputer industry very far. It was Intel's third design, the 8080 that changed the world, almost overnight it promised to be the foundation stone for the entire micro industry. In competition, Zilog, Motorola, and MOS Technology (now part of Commodore) brought out their own microprocessors, respectively, the Zilog Z80, the Motorola 6800 & the MOS 6502 (the chip from which the Apple, the Commodore PET, the Atari computers took birth)

8-bit microprocessors: The 8-bit chips are designed to manipulate data in 8-bit packages. These chips are the basic CPUs in the home computers. In the business computer market, they have largely been replaced by 8/16, 16, 16/32 bit chips & latest by 32 bit chips. The 8-bit was marvel of technology for its time because of its powerful addressing capabilities and its efficient architecture. It lent itself easily to adaption and improvement.

The main 8-bit processor is the Zilog Z80. The combination f this chip and the CP/M operating system of 1981 was the first y standard to appear; quite a welcome change from the era ... standards.

There have been other 8-bit industry standard chips, such as the Intel 8085, but none matched the Z80's wide acceptance in its heyday.

Today the Z80 & other 8-bit chips have become outdated & overtaken by faster & more powerful processors. It is not just that 8-bit chips are not poweful. The other main reason why buyers do not prefer 8-bit CP/M micros now-a-days is that most of the best software is written for the 16-bit market.

Popular microprocessors in the 8-bit range are: Intel 8080, Intel 8080 A, Intel 8085 A, Z80, NSC 800, MC 6800, MOS Technology 6502, Motorola 6809, etc.

8/16 Bit Microprocessors: Between the 8 bit and true 16 bit microprocessors we can place a group of hybrids, the 8/16 bits, that have some limitations of the 8 bit group and some advantages of the 16 bit group. The 8/16 bit chip has more processing power than an 8-bit chip

The designation 8/16 means that the chip uses 16 bit registers and move data internally 2 bytes at a time but talks to the outside world over an 8 bit data bus.

Only one, the Intel 8088 has achieved great success in the microcomputer industry. Zilog made an attempt to repeat its success of the 8 bit chip by introducing a 16 bit one, the Z8000, but this failed to catch. Intel dominated the market with a range of many industry standard processors.

These chips run with the widely used 16 bit operating systems MS-DOS, PC-DOS, CP/M-86, Concurrent DOS, etc., each compatible with a vast amount of excellent software.

Popular microprocessors in the 8/16 bit range are:

Intel 8088, Texas Instrument's TMS 9900, National Semiconductor's INS 8900.

Intel 8088: This is the chip which IBM chose for its personal computer. Intel's 8088 microprocessor is unusual. It has the attributes of both 8 bit & 16 bit chips It combines the increased capabilities of a 16 bit processor which can communicate with an 8 bit world. It is more powerful than 8 bit but the least powerful among the 16 bit processor. It is referred to as an 8/16 chip to distinguish it from the 'truer' full 16 bit chips, such as Intel-8086.

Use of the 8088 chip allows the IBM-PC to be compatib with both the standard 8 bit (like 8088/8085 chips) & 16 bit (lik 8086) hardware currently in use.

Because of its 8-bit external bus, the 8088 can use 8 bit support chips, a fact that adds to its cost effectiveness, a primary consideration in IBM's selection of this chip.

The 8088 (& also 8086) chip has 1 Mb direct addressing capacity with a 20 bit address bus. It also provides, 24 operand addressing modes, 14-word by 16-bit register set with symmetrical operations, as well as byte, word and block operations.

The 8088 is divided into two separate processing units:

1 Execution unit carries out all instructions.

2 The Bus Interface unit fetches instructions and move data between the 16-bit internal bus and the 8-bit external bus This enables the 8088 (and its full 16-bit brother, the 8086) to perform its computing functions internally while it is busy fetching and sending data back and forth. In other words, while the 8088 seems otherwise occupied by communicating with its 8-bits external environment, it is still doing its work within the internal 16-bit processor. This means that the 8088 is a faster microprocessor than its grandfather, the 8080.

IBM's entry into the micro market with the adoption of 8088 for its IBM-PC made a great success story of a microprocessor that otherwise would have passed unnoticed. The IBM's continued patronage assured it a status of a leader. However, as soon as IBM announced a successor to its PC which runs on a more powerful 16-bit chip, the 8086, the 8088 is fading away.

16-bit Microprocessor: Ex-Intel 8086, Zilog Z8001, Zilog Z 8002, Motorola 68000 (Motorola is actually a 16/32 hybrid).

Intel-8086: It is a full 16-bit version of the 8088 and more powerful than 8088. The last digit '8' in the 88 means 8 bit, the '6' in 86 means 16-bit. There is very little difficulty in moving from 8088 to 8086 for the programmers since the programs written for the 8088 & 8086 are mutually compatible. The 8086 has the same architecture, addressing modes and set of instructions as the 8088 except for the Bus interface unit (BIU). The 8088 BIU communicates with an 8 bit external bus, that is, it receives data in 8 bit [illegible]s. The 8086 can communicate with a 16 bit external bus i.e.

TABLE 6 2

Comparison of Some Important Microprocessors

	Intel	Intel	Zilog	Intel	Zilog
Code/Identity of chip	8088	8080	Z80	8086	Z8000
Year introduced	1972	1973	1976	1978	1979
Data path width (bits) or Data bus	8	8	8	16	16
Address Bus (Bits)	20	16	16	20	16
Directly addressable* memory space	16K	64K	64K	1024K	8192K
Clock speed (MHz)	5	2	2 5 to 6 0	4 to 8	4
No of Registers	14	7	17	14	17
Number of pins	40	40	40	40	64
Resident program memory	None	None	1K	None	None
Relative throughput (8008-1)	1	10	20	100	100
Power supply required, (volts)	+5 —9	+12 +5 —5	+5	+5	

***Addressable space — The amount of memory available for use by the microprocessor.**

receive data in 16 bit units & therefore, it does not have to convert data recieved in 16-bit units to 8 bit units for processing purposes

The *internal and external functions on the 8086 permit* the chip to perform tasks at the same time which other chips have to perform sequentially. For example, a Z80 chip requires an interrupt to take place before the instructions, for performing an input or output data communication function, can be executed. The input or output function on the 8086 chip can take place while the chip's internal processor is working away.

If one has a choice, one should not go for 8088 based micro, rather he should opt for 8086. One might think that micro-computers using the 8086 cost much more than 8088-based models In fact, there is no price difference at all or the 8086 may even be cheaper.

Other 16-bit Chips

80186: It is a 16-bit chip slightly more powerful than 8086 16-bit but most of the 8086 software is not quite fast with 80186.

80286: This is the most powerful among the 16-bit chips. It is used by IBM on its IBM-PC/AT Th: introduction of more and more AT compatibles is causing wide popularity to this microprocessor

Unfortunately, not much fresh software has yet been written for 80286 so that it's being run with the wide software written for 8088/8086 This downgrading lowers the performance of 80286 in the sense that it works at 8086 speed when used with 8086 software Once the software modified or specially written for 80286 becomes available the capabilities of 80286 would become more obvious and the chip would be appreciated and accepted by one and all

The 80286 does have one disadvantage It belongs to the 16-bit group of chips from Intel (8088, 8086, 80186, & 80286 Thoug most chips in the group can run software written for the other chips, for example, the 80286 can run all software for 8088, 8086, & 80186, unfortunately, the other chips cannot run every software written specifically for 80286 This is one factor for slow acceptance of 80286 by the users used to 8088 and 8086.

16/32-bit Chips: Motorola 68000 is a hybrid 16/32-bit chip. People have varied opinions about it. Some find it more powerful than 80286, some find it to have a number of drawbacks. It is no doubt very good for application involving sorting of large database. It is very appealing for multiuser purposes unlike the 16-bit chips which mostly have single-user operating systems. Software is available widely for these applications

The 68000 does have some disadvantages. The greatest problem is software for general purpose applications The chip is generally used with different operating systems on 16-bit chips from Intel, UNIX & XENIX being very common The word-processing application package, for example, which runs well on UNIX, does not run on 68000 operating systems Another problem is price. Micros based on this chip are very costly compared to the ones based on 16-bit chips including 80286.

32-bit :—

The latest craze is the full 32-bit chips. The micros based on these chips have recently been introduced in the market. This is a fast developing field and many chips are competing with each other for the crown position i.e., an 'industry standard'. We shall discuss the most prominent, the 80386 chip.

80386—The High Performance 32-bit Microprocessor*

* High Performance CPU
  —2 to 3 times 286 performance
  —Pipelined implementation
  —Multiple on chip caches
  —High bandwidth 32—bit bus
  —12 and 16 MHz clock.
* Software compatible with 8086, 8088, 80186, 80188 & 80286 micros
* Complete 32-bit supermicro
  —8, 16, and 32 bit data
  —integrated multitasking support
  —On-chip virtual memory support.
* Complete support for 32 bit addressing
  —2^{32} bytes of physical address space.
  —2^{32} bytes per segment
  —2^{45} bytes of virtual address spaced per task.
* Multiple Co-processor interface
* On chip memory management and protection
  —fully compatible with 286.
* Optional On chip paging
* CHMOS III technology.

The 386 is the latest member of the 86 family & the first 32—bit microprocessor. Known by the name 'iAp x 386' it maintains software compatibility with the entire 86 family (8086, 8088, 80186, 80188 and 80286), while adding 32-bit and supermicro capabilities and significantly enhanced performance.

The 386 brings new performance standards to the microprocessor world. The combination of advanced process technology

and architectural concepts which were previously found only on mainframe and large minicomputers make the 386 the highest performance microprocessor in its category. Concepts such as caching, pipelining, high performance bus, and a high speed execution unit provide this level of performance at both CPU and system level.

The 386 provides access to the large base of software developed for the 8086, 8088, 80186, 80188 and 80286 micro processors. It maintains binary level code compatibility with these earlier generations to allow execution -- existing applications without recompilation or reassembly. The user preserves his software investment and can reduce the time to market for new products

The 386 provides full 32-bit supermicro support, 32-bit architecture and internal implementation, including registers, arithmetic and logic unit instruction set, addresses, address bus and data bus, provide the functionality needed to build a full 386 based, 32 bit system

Supermicro capabilities, such as hardware supported multi-tasking and virtual memory support, provide the foundations necessary to build advanced multitasking and multiuser systems The hardware multitasking support of the 386 automatically stores the task state and loads the new task during task switch operations The on-chip memory management and protection mechanism performs the mapping from virtual to physical memory and provides the protection necessary for maintaining task integrity in a multitasking environment. Optional paging allows for a finer granularity of physical memory management.

The 386 supports a full family of specialized coprocessors. Coprocessors allow separation of specialized functions at the component level, so that the user can tailor the system's functionality and performance to his application while optimizing the design for cost. Multiple coprocessors are supported by the 386, such as the new numerics coprocessor for the 386, the 80387, the Ethernet Local Area Network coprocessor, the 82586, and the text co-processor, the 82730.

The 80386 is designed for applications requiring high CPU performance, bus bandwidth and address space. The 80386 pro- -es access to the 32-bit world, 32-bit data types.

The 386 addresses two other important issues:

(i) It gives system level support to systems designers by providing an integrated memory management capability which has virtual memory support , optional on-chip paging, four levels of protection and an integrated task switch.

(ii) It also is object code campatible with the entire family of 8086 microprocessors, 8086/88, 80186/188 and 80286 The flexibility provided by the 386 not only affords the installed base of 16-bit software immediate access to the latest processor technology, but also allows these object-code modules to run concurrently. For example, PC–DOS programs written for the 8088 can exist beside UNIX or XENIX code or can interact directly with 32–bit software written specifically for the 386

Packaged in a 132 pin ceramic pin grid array, the 386 is fabricated in Intel's CHMOS III process. Using this technology, the 386 is designed to operate at 12 MHz and 16 MHz and dissipate between 1.5 W and 3.0 W. It has demultiplexed 32-bit data and address buses which allows a 32-bit access in only two clock cycles.

Processor Organization: Six functional units make up the 386. These six units are arranged in a pipeline that enables them to operate in parallel on different instructions or on different parts of the same instruction.

(i) The **Bus unit** performs bus transactions for the other units.

(ii) When no other unit needs the bus, the **prefetch unit** reads the next word of the instruction stream from memory into the prefetch queue. Most code fetches are performed in parallel with execution using unneeded bus cycles.

(iii) The **decode unit** cracks each opcode converting it into a pointer to the microcode that implements the instructions.

(iv) The **execution unit** executes the microinstructions and can add two 32 bit registers in two clock periods. Multiply and divide hardware performs 32-bit multiplications in 20 to 40 clocks, depending on the number of significant digits and 32-bit division in 40 clocks. Shift rotate and the new

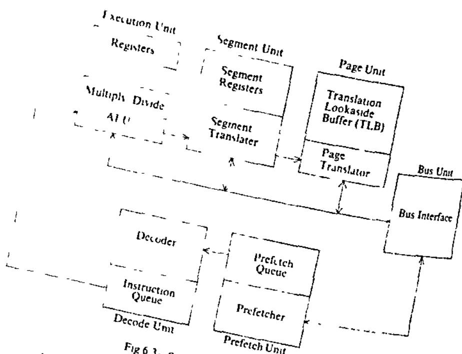


Fig 6 3—Six Functional Units of 386

bit field instructions aided by a barrel shifter than can shift up to 64 bits in a single clock. The on chip MMU consists of segment and page units.

(v) The **segment unit** translates logical addresses to linear addresses and checks each access for consistency with segment protection attributes. For the majority of instructions, the segment unit obtains the translation and protection data from the on chip segment and descriptor registers.

(vi) The **Page unit** is enabled or disabled by operating system software. When paging is disabled the linear addresses produced by the segment unit pass through the page unit unaltered. When paging is enabled, the page unit translates linear addresses into physical addresses and verifies that access are consistent with page attributes. The page unit includes a 32 entry. Translation Lookaside Buffer (TLB) that caches the translation information for the most recently used pages. Using the TLB the page unit can translate most page accesses (typically 97-99 %) without consulting the memory based page tables. When necessary the page unit initiates the bus cycles required to return an elder TLB entry to its page table and to load the vacated TLB slot with the page table entry referenced by the current instruction.

Performance: The 386 provides two to three times the performance of the industry performance leader the 286 A combination of advanced technology, pipelined architecture, on-chip code and descriptor caches, high performance bus and high speed co-processors provide this improvement. With the higher execution speed, the designer can develop more complex systems and applications, increasing the appeal of his end product to the market

CHMOS III Process: Intel's advanced CHMOS III process (Complementary High Speed Metal Oxide Semiconductor) eliminates the frequency and reliability limitations of traditional CMOS processes and opens a new era in microprocessor performance It combines the high performance capabilities of Intel's leading HMOS III technology with the high density and low power characteristics of CMOS Using this technology, the 386 is designed to operate at 12 & 16 MHz

High Speed Bus: The 386 implements a 32-bit data path and 12 MHz or 16 MHz bus clock to provide a throughput rate 2 to 4 times that of current microprocessor systems. This high speed bus increase overall system performance by insuring prompt transfers between the CPU, memory and peripherals without becoming a bottleneck for the system An estimated system performance increment of about 20% is achieved via this high speed bus.

Coprocessors: To provide even higher system performance, the 386 will support advaned coprocessors. The 80387, the numerics coprocessor for the 386, is software compatible with the 8087 and 80287 and will perform numeric calculations at more than 4 times the speed of the 287. Numeric intensive applications in a 386/387 system will run significantly faster than even the performance leading 286/287 systems.

Other coprocessors will also support the 386. For example, the 82586 Ethernet LAN and the 82730 Text coprocessors will run with the 386, offloading the CPU of the functions for which these two coprocessors are specially designed, further increasing system performance.

Supermicro Supporot: The 386 provides 32 bit support as well as Supermicro support. Data types, registers and instructions have been expanded to support 32-bit systems

Data Types: The data types are the same as in the 286, arithmetic, floating point, byte string and bit field. Table presents an overview of the data types available under each category

TABLE 6.3

	Data Types
Arithmetic	8-, 16-, 32 - bit integers
	8-, 16-, 32 - bit ordinals
	unsigned packed decimal — BCD
	unsigned unpacked decimal — BCD
Floating point	Supported in 80387 coprocessor
	16-, 32-, 64 — bit integer
	32-, 64-, 80 — bit IEEE P754 standard
	80 — bit decimal format
Byte string	Variable length 0-4 gigabytes
Bit field	1 or more bits

Instruction Set: The 386's instruction set provides for full 32-bit data manipulation and addressing in addition to 8 and 16-bit data, and 16-bit compact addressing. The 386's instruction set is a superset of the 286's and allows full compatibility with the 86, 186, and 286

All existing instructions have been extended to support 32-bit addresses and operands. New bit manipulation and other instructions have been added for extra flexibility in designing complex software Operating systems, compilers and graphics applications will benefit from those new instructions.

Register Sets: The 386 microprocessor has a total of 34 registers divided into the following Categories: General Purpose Registers, Segment Registers, Status and Control Registers, Systems Address Registers, Debug Registers and Test Registers. The general registers of the 386 support 32-bit data and addressing They also provide for 8 and 16-bit data and 16-bit compact addressing, thereby offering total software compatibility.

The segment registers of the 86 family are identical in the 386 with the addition of non-dedicated segment registers, FS and GS, for increased flexibility in simultaneously manipulating multiple lata structure.

lemory Addressability: The 386 provides complete 32 bit addres-bility to very large memories Table indicates the memory dressability of the 386

Table 6.4

Memory Addressability

Physical Memory	4 Gigabytes
Segment offset	4 Gigabytes
Virtual Memory Per Task	64 Terabytes

The 386's large addressability allows for direct mapping of the large mass storage devices that will be available in the future, such as advanced winchester and video disks, into virtual memory

Effective Addressing: The 386's effective addressing is an expansion of the 286 model. Just like in the 286, an optional base is added to an optional index and then to an optional displacement to provide the offset. The 386's mechanism is fully compatible with the rest of the 86 family. Table indicates the choices available for address calculation.

Table 6.5

Address Calculation

16-Bit (86/186/286 compatible)		32-bit
CS, SS, DS, ES	Segment	CS, SS, DS, ES, FS, GS
	+	
None, or 16-bit base register	Optional Base	None, or 32-bit base register
	+	
None, or 16-bit Index Register	Optional Index	None, or 32-bit Index Register
	+	
None, 8, or 16-bit	Optional displacement	None, 8, or 32-bit

Multitasking: Many advanced applications require multiple activities to be in process at any given instance. This requires system

to perform task switches frequently. To improve the performance of these systems, the 386, just like the 286, offers hardware integrated multitasking. What this means is that the traditional steps involved in task switching, storing the task context, loading the next task and giving it control, are automatically performed in hardware This simplifies operating system development by moving most of the task switch chorus to the hardware, while at the same time improving performance. Hardware supported multitasking execution takes a lot less time than a software implementation The system can switch among many tasks quickly and often, without incurring performance degradation.

Software Compatibility: The 386 continues the evolution of the 86 family by maintaining full compatibility at the object code level with the 8086, 8088, 80186, 80188 and 80286 microprocessors This compatibility provides immediate access to the largest base of 16-bit microprocessor software in existence. The user & designe preserve their investment in software, both applications and operating systems and can add new software to their system quickly and efficiently

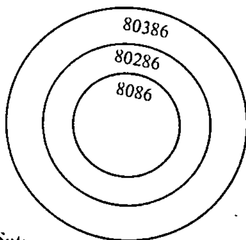


Fig 6.4 Software Compatibility in 86 family

To utilize the majority of the application software, no re-compilation or reassembly is necessary. Exceptions might exist for eed or input/output configuration dependent software, but the jority of the software will run unchanged.

The shortest word length is 4-bit but this gives only 2^4 i.e 16 different values which is inadequate for representing even the 26 alphabets. The 4-bit chip is therefore suitable only for mathematical purposes where the digits only from 0 to 9 need be represented & therefore, it's widely used in calculator applications where arithmetic operations are performed in binary coded decimal & one decimal digit is processed in one operation.

The next word length is 8-bit (why not 5 or 6 or 7 ? We shall come to it shortly) giving 2^8 i.e. 256 different values which is adequate to represent even the full ASCII character set of 128 symbols. This length is good for text applications like word-processing.

A typical 8-bit general chip has an 8-bit data bus, a 16-bit address bus. It can interface with up to 64KB of external ROM or RAM in any combination. Its arithmetic capabilities are quite basic & it has a simple instruction set which relies on the use of an array of on-chip registers for its successful operation.

The 8-bit data word length makes these microprocessors capable of handling the full set of alphanumeric characters (in fact an 8-bit chip can handle 2^8 i.e. 256 symbols). Also the instructions are executed very fast which makes these chips to have a basic data processing capability. They are therefore used for general applications like wordprocessing, database management, games, mathematical modelling etc. They are very much used in micro-computer systems where with proper interfacing, these chips can drive monitors, printers, floppy disks, hard disks & so on.

An 8-bit chip is capable of performing any task for which a program can be written. However in applications requiring high processing or high volume production ...

[illegible] ... the cost may prohibit such an approach. In these cases ... circuitary can be added it is better to go to higher bit chips.

The next word length is 12-bit, however, it has not got much popular. Rather the next i.e. 16-bit chips have got a wider application base.

Let us try to discuss why it happens ... chip ... 8-bit, 16-bit & now 32-bit only have ... bit, ... omputers & not the sizes in betwee... ...t the chip complexity does not inc... ...size but in a series of quantu... ...um

It is quite obvious in the semiconductor memory field where memory sizes have increased from 16 bits around 1960 to 256 bits, 1Kb, 4Kb, 64Kb, 256Kb & now 1Mb. The memory density has quadrupled with each new generation of semiconductors.

The step increase in both semiconductor memory sizes & microprocessor bit-sizes has been due to the developments & improvements in the fabrication technology of semiconductors & microprocessors. It so happens that a quadrupling of chip complexity permits a doubling of microprocessor word length. Therefore the chips developed into 4, 8, 16 & 32-bits. It is not that chips with word sizes in between cannot be prepared. However, the production cost would be higher & also when a 32-bit chip is available at a lesser price than say a 24-bit chip one would rather opt for a 32-bit which is also more capable than 24 bit.

The 16-bit word length became very popular & soon was established as a minimum standard for serious applications. These chips challenged the minicomputers which were too expensive. With 2^{16} i.e. 65536 different values possible it can represent most real-world variables with a single word (our general purpose vocabulary is about 50000 to 100,000 words). One can now imagine how easy word-processing would be with a 16-bit chip.

Some Widely Used Microprocessors

8-bit: Intel 8080, 8080A, Z80, NSC800, MC6800 MC6809, MOS TECHNOLOGY

8/16 bit: Texas Instrument TMS 9900, Intel 8088,

16-bit: Intel 8086, Zilog Z8000, Zilog Z8002, 80186, 80286

16/32 — Motorola 6800

32-bit — 80386, Motorola 68040

C-MOS Chips: Sometimes you will come across chips with the letter 'C' in the middle of a familiar chip number, e.g., Intel-'80C86'. This means that the processor has been made with 'C MOS' technology. It's enough for us to know that these processors use less electrical power than the ordinary ones and hence are very useful for portable microcomputers

Some Manufactures & Their Microcomputers

1. Intel: Intel Corporation, a major microprocessor manufacturer of 4, 8, 16 & 32 bit chips, owned in part by IBM.

2. Zilog: Manufactures of microcomputers-including Z-80 & Z-80A
3. 8080-Chip- 8-bit system developed by Intel. The first chip adopted for widespread use in business microcomputers.
4. 8085: Faster version of the Intel 8080-is software compatible with 8080.
5. Z-80: An 8-bit microprocessor developed by Zilog Inc.
6. 8088: The chip at the heart of the IBM-PC, using a 16- internal structure and an 8-bit external structure.
7. 8086: A 16-bit microprocessor produced by Intel.
8. 80186, 80286: 16-bit microprocessor produced by Intel.
9. 80386: Latest 32-bit microprocessor produced by Intel.

7.

Main Memory—RAM & ROM

A human being has different levels of memories. Short-term-memory when the thing is not important & he need not remember it, like the train ticket number when one travels from Delhi to Bombay. Such information needs to be recalled for the 'time-being' & then forgotten or erased. Long term memory when the thing is important & one must remember, like every human being remembers his own name. Such information needs to be stored as a permanent record in the brain [At least till one might acquire a new name after which the old name may be erased from the memory!].

Computer has three levels of memory:

1. Main or prime memory.
2. Mass memory.
   Mass memory in turn can be divided in two categories.
   (i) Secondary or auxiliary memory.
   (ii) Back up memory.

Main : This is the memory matched to the CPU. It is fast & available for instant communication. The memory is accessed parallely & randomly.

Secondary : It is readily accessible data library. It stores information at a lower cost per bit. It is accessed serially & sequentially & has moderate speed. It is the data warehouse of the computer system.,

Back up : Back up means protection. It is used to save data in the event of catastrophic failure. Like secondary memory, the back up memory also is the warehouse of the computer system. Back up memory system must have large storage capacity [& hence, it is also a mass memory] at low costs.

The various levels of computer memory can be compared with a library of books. A library has thousands of books. One can go through the whole library but can actually read only one

TABLE 7.1

Comparison of Primary, Secondary & Back up Memories

	Primary	Secondary	Back up
Storage cost per bit	High	Moderate	Low
Processing	Parallel	Serial/Parallel	Serial/Parallel
Speed	High	Moderate	Slow
Access	Random	Quasi-sequential	Sequential
Capacity	Low	Moderate	High
Examples	Chips	Floppy disk, winchester disk, Bubble	Floppy disk Magnetic tape Magnetic cartridge Video tape

book at a time. When one book is finished it is placed back on the shelf & another picked up. New books may be added to the library from time to time. All the information contained in the library can be made available on tiny things known as microfilms which can be preserved safely.

A microcomputer's memory is organised on similar lines Prime or main memory is the single book one is actively reading. Secondary memory is thousands of books readily available on the shelf. Back up memory serves the same purpose as the protected microfilms.

Main Memory : Two types of main memory are found in microcomputers.

1. Random Access Memory [RAM]
2. Read Only Memory [ROM]

RAM can be of three types :

1. Static RAM—Memory requiring only DC power supplies.
2. Dynamic RAM
3. Magnetic-core RAM

ROM can be of many types like :

1. PROM
2. EAROM
3. EPROM
4. EEPROM
5. CMOS-PROM etc.

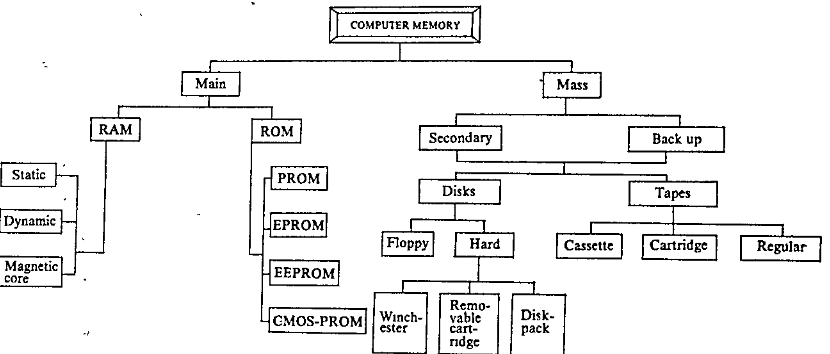


Fig.7.1—Computer memories

We shall discuss RAM & ROM in detail.

RAM & ROM

To survive, we need two types of memory. First, a permanent memory acquired since birth, for instance to regulate automatic breathing & heartbeat. It is the memory associated with instincts, the 'genes' of a person. ROM is similar to this type of memory.

Second, the memory needed for storing what all new information will come in later years of our life. For instance how to multiply, how to put a TV on, how to eat & so on. RAM is analogous to this kind of human memory.

TABLE 7.2

Comparison of RAM & ROM

Characteristic	RAM	ROM
Processing	Parallel	Parallel
Storage device	IC chips	IC chips
Access	Random Access	Random Access
Read/write capability	Both read/write capability	Read only capability
Volatility	Volatile	Non-volatile
Speed	High	High
Permanence	Temporary	Permanent (Firmware)

Read & Write :

'Read' means to copy a number non-destructively from one location to another. Read is non-destructive because whatever was in the location read from, is still there afterward.

'Write' means to store a number destructively in a location. Writing is destructive because whatever was in the location before writing into it is destroyed when the new value is written in.

Random VS Sequential Access :

Sequential access & random access are the terms used to describe how a computer finds the desired information from whole of data on a storage device

The ability of a device to read or write data at a particular position is known as random access. Random access means that the computer can go directly (i.e. randomly) to any information. Floppy disk or hard disk drives are known as random access storage devices (RASD). On the other hand, if data must be read or written in a consecutive order it is known as sequential access. It means that the computer searches the whole information one by one to find the desired one. A cassette tape recorder is known as a sequential access device.

To explain the two phenomena, let us consider a telephone directory. It is printed in alphabetical order. When you want to search the phone number of a particular person, you use the alphabetical order to find his name and the phone number in front of his name. In this case, you have access to the information of phone numbers directly so, it isa case of random access.

However, if you know a phone number & want to know the name of the person, you would have to go through every entry since beginning, till you reach the desired one. A very laborious & time consuming job. This is the case of sequential access.

To take another example, a book from the racks of a library can be easily located after locating its reference number from the subject/ author index card files. After knowing this number, we can straight go to the book and pull it off the shelf, without having to start with the lowest numbered book and look at every book until we get to the one we were searching for. It is another case of random access.

The random access is little misleading. It does not mean that the computer goes through the information in a haphazard manner. What it means is that the computer can directly access to every part of the information The term random is rather associated to our way of choosing the piece of information. The all it means is that if we choose any information at random, the computer can go to that information as quickly as to any other.

Sequential access is slow but simple & reliable. The time it takes to find a particular information depends on the size of the complete information (technically known as database) & the position of the particular information (technically called a record) in the database. If the database is large & the desired record is near the end, it would take longer, than if the record is near the beginning.

The average access time in case of sequential access, is half the time required for the computer to read the complete database. For example, if a computer takes 30 seconds to read the database, the average access time is 15 seconds.

Random Access Memory [RAM]

Place inside the computer where the data-to-be-processed & the programs-to-be-executed are stored is known as internal memory or main memory of the computer.

Computers have RAM & ROM both as their main memory but generally, major portion of the memory is RAM. In fact, RAM is the actual usable or general purpose memory.

The characteristics of RAM are:

(i) Random Access means that we can access (get-to) any individual memory location directly, without having to go through any other memory location first

(ii) Read/write capability RAM is called read/write memory of the computer since, it has both read and write capability. It means that we or the CPU can read from and write onto this memory. Every location in RAM is addressable. A 16K RAM memory means that 16 × 1024 i.e. 16,384 addressable locations are available in the memory starting from address number 00000 to 16383.

(iii) Fast: It is used in computers due to extremely fast access of the information stored in RAM. The programs are loaded into RAM so that program instructions are immediately available for execution The CPU then transfers the data to be processed to RAM. The rate of data transfer to RAM depends on the size of the RAM & it is generally transferred in small batches.

Since RAM is costlier than mass memory, the data is normally stored on mass storage deviced like floppies & hard disk which are comparatively cheap.

(iv) Temporary: A characteristic of RAM is that nothing is kept there permanently.

The memory stores the data in it only as long as power is supplied. If the microcomputer is turned off, or if the power fails, all the data or programs stored in the computer's memory are lost

RAM is therefore also called as a volatile memory. After destruction, if the microcomputer is put on, random values are stored in all the memory locations. These random values are called 'garbage' because they have no meaning to us.

To preserve the information in RAM, one can store it, say on a floppy disk, before putting the machine off.

(v) Actual working memory: A computer's RAM is like an office-table. It contains only those files which have just been dealt, are being dealt & are about to be dealt. It is the actual working area of a person working in an office

RAM is not the same as disk storage which holds data permanently, like files are stored in a filing cabinet. It is also not like ROM where also the programs & data are stored permanently

The instructions and data are stored in RAM After processing the data, the computer puts it back in RAM. The amount of RAM decides how much data or how large a program can be loaded to the computer at once.

How Much RAM

RAM is more important than ROM from the user's point of view. He can overlook ROM while assessing a computer & just concentrate on RAM. It is the amount of this memory which is called the user memory. The key question is—How much RAM is available to the user? Typical amounts of RAM are 64K, 128K, 512K & even 1 M.

The RAM available with your computer is required for many purposes. Part of the RAM is required for operating system & other overheads; the rest is available to the user for application programs.

Each software package, to be run on a computer, requires a minimum amount of memory. So, which package you can use on your computer is determined by the amount of memory your computer has. You should acquire enough memory for the computer so that out of the packages you want to use, the one having maximum memory requirement can also be run on your micro.

Different micros have different memory capacities. Some can store 264000 characters while others may store as less as 2000 characters only However, the memory of most of the micros can be expanded. The limit of expansion also varies with comp

Many computers are limited to about 32000 characters, while some allow addition such that a total of 1,000,000 (1 MB) characters can be stored. Most applications can be successfully handled with about 1,20,000 characters of memory, however, applications like wordprocessing, database, spreadsheet etc. require more memory.

You should not buy a micro costing less but with lesser RAM than the minimum you would require in practice. Getting the right amount of RAM at the beginning is better than going for lesser RAM, though, you can 'upgrade' later on. Also, the additional amount you would spend in upgrading the RAM upto required level compensates or rather exceeds the saving initially apparent on a low-cost system

Till sometime back, RAM was very expensive. Even big computers had RAM in the range of 32K. Of late, however, the cost of RAM chips have been falling regularly & more & more RAM is available even on smallest computers. The 8-bit micros of 1980 had RAM of 64K; with 16-bit micros, 128K is the starting level, & 256K was the minimum most of the buyers would opt for. Persently with 16/32 & 32 bit bytes, 512K & even 1MB is most common

One of the features of microcomputers which is prominently advertised is about its main memory. An advertisement claiming a "256K" refers to the amount of main memory in bytes.

Beware of catchy advertisements You may find a 16-bit micro offered with 64K RAM. You may be quoted very low price, but the micro is of little use since most of the industry standard 16-bit operating systems need at least 128 K RAM

Why More RAM Is Good: There are a mumber of advantages in having more RAM

(i) All application programs require a minimum amount of RAM, & the best ones need more than 128K or will perform betterwith more of RAM. With the rapid development of software industry, programs are developed which need more & more of RAM & even 256K is not enough for some 16 bit software

(ii) More RAM means better performance

(iii) RAM level is a vital factor in deciding the performance multi-user systems

To the user RAM is very important & generally you have a choice of how much RAM you can get.

If you have a particular software in mind ensure that it would work on the amount of RAM your micro supports.

Upgrading RAM

Regardless of the amount of memory that comes with the computer you'll need more of it sooner or later. Maybe you can do a lot with memory already available, but you could do still more if you had more memory.

Most micros offer the option to add more of RAM later, i.e. after the system has been bought. Adding RAM is quite simple & cheap now. The larger the addition, the lesser the money spent per kilobyte.

When you add memory to some computers it is necessary to add several control circuits called memory boards or circuits in addition to the chips. These boards cost more than the chips.

The original manufacturer of a micro generally charges more for extra memory than the non-approved suppliers. If you buy memory from other than your micro supplier, it is possible to save lot of money. However, your warranty from the manufacturer becomes void. In the process of installing additional memory by opening up the system yourself, there is a possibility of damage to the computer. You should therefore, consider pros & cons of cheap memory VS risk of damage.

Adding memory is not so risky with computers such as the IBM PC. These computers have room for some memory expansion in the basic computer. The memory expansion is just a matter of plugging in chips or a circuit card into the sockets on the computer. The sockets are already there, all you have to do is buy the memory chips seperately & plug them into the sockets. There is nothing to cut, solder, or modify. This way the IBM is capable of using up to 500K of memory. You can add up to 256K of memory to the IBM-PC by plugging in chips, but additional memory must be added by plugging in more expansion memory cards. It is useful to note that plugging in of memory chips does not violate the warranty.

Read Only Memory [ROM]:

Read Only Memory means that we or the microporcessor

can read data from it but cannot write data onto it. If we try to write to ROM, it won't accept the new data. ROM, like RAM, is also usually randomly accessible.

ROM is permanently stored into the computer system. When power is put off, contents in ROM are not lost. Like nothing can be added to ROM, nothing can be deleted from ROM.

If a program is stored on ROM, it prevents the program from accidentally being erased or changed. All types of ROM are non-volatile i.e. the data is not lost when power is put off. When the microcomputer is turned on, the ROM locations contain the same values that they did before it was turned off.

It's for this reason that ROM is primarily used by manufa turers for permanently storing certain instructions & featur which govern the operation of a computer. For instance, a program like 'Monitor' is stored in ROM. Similarly the BASIC interpreter program which permits the user to program in BASIC language is generally stored in ROM of a microcomputer. Such programs are said to be firm-wired.

Many computer manufacturers provide software in ROM. The removable game cartridges for a video game is many ROM chips put together and sealed in a protective plastic package. If one opens the case of such a cartridge, one can see a small circuit board with many ICs (Integrated circuits or chips) on it. Most of these ICs are ROM chips. By having ROM chips on a removable cartridge, the computer can be used for many other jobs.

Some computer manufacturers put the ROM that contains BASIC on the main computer board (the mother board). For instance, IBM-PC stores the instruction for the version of BASIC in ROM. It is not removable & therefore, occupies memory, whether it's being used or not. If it required say 16K of memory and the computer has total 64K memory (RAM + ROM), then 48K memory only is available to the user.

It's better to have ROM on permanent board if the computer would be used for a single purpose, but for multipurpose uses, as much as possible, ROM should be put on removable cartridges. Removable cartridges permit you to romove one and insert another. For example, if you don't want to work with BASIC, the cartridge containing it can be removed and another cartridge say 'C' inserted which would not need extra memory but would use the memory earlier occupied by BASIC.

In fact, good micros have only a few instructions in ROM installed permanently. The other instructions, programs etc can be loaded in the RAM from a disk or a cassette.

There are special types of memories, which are much more expensive than regular RAM & ROM But costs are likely to decrease with time & soon these memories will also be commonly used (Table 7.3).

TABLE 7.3

Different ROMs & RAM

Memory type	Programmability	Volatility	Representative size (KB)
PROM	Programmable Once	Non-volatile	16
EPROM	Reprogrammable	Non-volatile	32
EAROM	Reprogrammable	Non-volatile	1
ROM	Fixed	Non-volatile	16
RAM	Variable	Volatile	32

PROM

ROM chips are usually custom built by manufacturers. They are not available to the user to write or store data in it. There are some ROMs called PROMs (Programmable read-only memories) that can be programmed by the user. Such a PROM chip starts out containing a number of feasible links. The desired program is stored in the PROM, & then a high current is applied The program is permanently stored by blowing appropriate links and retaining others.

EPROM

Other ROM chips called EPROMs (Erasable programmable read only memories) can be erased by applying ultraviolet light, then they can be reprogrammed EPROMs are programmed with an electrical stimulus rather than with links as PROMs.

EAROM

There are still others, called EAROMs (Electrically alterable read only memories) which can be both programmed and erased

with electrical stimuli. Data is not lost when computer is switched off. To erase, a special electrical signal is to be used.

CMOS RAM: (Complimentary Metal Oxide RAM)

It can be kept stored by batteries. When power is put off, the data in the memory is not erased because of supply of power from the batteries. It is a special type of RAM that is put in an 'idle' state so that it uses extremely low power & can hold data for long times (even months) by surviving on tiny power from the battery of a small computer. It is normally provided with portable computers.

Bubble Memory

Bubble memory is both like ROM & RAM. It is like ROM in the sense that when power is turned off the contents in bubble memory are not lost. It resembles RAM because one can alter the data stored in it. It iscapable of storing million of bytes of data in a very small circuit The disadvantage of bubble memory is that it isslow to accept & output data compared to 'pure' RAM or ROM.

Some portable computers, specially expensive ones, use bubble memory for storage purpose. They provide convenient & reliable storage for 'moving' computers.

RAM DISK

You may often see advertisements for devices called RAM disks. Essentially a RAM disk is a circuit card containing thousands of bytes of RAM memory in a circuit. The computer 'treats' it as another disk drive (e.g., drive 3 in a dual drive system) However, you can store and retrieve data from a RAM disk much faster than you can from a disk drive. During the running of a program, if the temporary files required are stored on a RAM disk, the program will run much faster. The cost of RAM disks are falling gradually & they have a great future.

Many other forms of RAM are available for many computers.

8.

Mass Memory and Storage Devices— Tapes

Mass Memory & Storage Devices

The main memory of the computer, consisting of RAM & ROM, is very fast working memory required for fast CPU operations. ROM & RAM both have fixed capacities, the values depending upon a particular computer model. ROM is not available for user data & programs. RAM is a temporary memory. Once the computer machine is switched off, whatever is written in RAM is lost. Also once RAM is filled up, new data cannot be stored unless the old data is removed.

To make computers workable, some form of permanent storage is therefore required. This permanent storage device serves two purposes; it holds the data that spills over from RAM & also it stores the software which can later be loaded into the RAM when the system is switched on.

Mass memory is used to store the information you want to save & use in future, like an audio songs tape is used to preserve 'memories' of sounds. It is less expensive than main memory. Also it is slower than main memory, more than a thousand times slower. When power is turned off, main memory may be erased but mass is not. Mass storage is thus, cheap, reliable & easy to use, but slow.

For microcomputers, the generally used devices for secondary & back up memories are:

1. Cassette tape.
2. ½" & ¼" magnetic tapes.
3. Floppy disk.
4. Video tape.

Cassette VS Disk

In the home computers, Cassette tapes are commonly a means for permanent and removable mass storage.

with electrical stimuli. Data is not lost when computer is switched off. To erase, a special electrical signal is to be used.

CMOS RAM: (Complimentary Metal Oxide RAM)

It can be kept stored by batteries. When power is put off, the data in the memory is not erased because of supply of power from the batteries. It is a special type of RAM that is put in an 'idle' state so that it uses extremely low power & can hold data for long times (even months) by surviving on tiny power from the battery of a small computer. It is normally provided with portable computers

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Mass Memory and Storage Devices— Tapes

Mass Memory & Storage Devices

The main memory of the computer,consisting of RAM & ROM, is very fast working memory required for fast CPU operations.ROM & RAM both have fixed capacities, the values depending upon a particular computer model. ROM is not available for user data & programs. RAM is a temporary memory. Once the computer machine is switched off, whatever is written in RAM is lost. Also once RAM is filled up, new data cannot be stored unless the old data is removed.

To make computers workable, some form of permanent storage is therefore required. This permanent storage device serves two purposes; it holds the data that spills over from RAM & also it stores the software which can later be loaded into the RAM when the system is switched on.

Mass memory is used to store the information you want to save & use in future, like an audio songs tape is used to preserve 'memories' of sounds. It is less expensive than main memory. Also it is slower than main memory, more than a thousand times slower. When power is turned off, main memory may be erased but mass is not. Mass storage is thus, cheap, reliable & easy to use, but slow.

For microcomputers, the generally used devices for secondary & back up memories are:

1. Cassette tape.
2. ½" & ¼" magnetic tapes.
3. Floppy disk.
4. Video tape.

Cassette VS Disk

In the home computers, Cassette tapes are commonly used as a means for permanent and removable mass storage. The dis-

advantages with them are that they are slow, do not store much data and it is difficult to locate the information needed. A large program on a cassette for example may take minutes to load. In microcomputers used for business applications, therefore, another medium called 'disk' is used for mass storage. The 'disks' are available in two forms.

1 The 'Floppy' disk &
2 The 'Hard' disk.

Disks are faster, & very reliable. However, they are comparatively expensive They are the best storage systems for micro computers today.

TAPES:

Three main types of tapes are used with computers:—

(i) The cassette tape.
(ii) The cartridge tape.
(iii) The regular tape (or magnetic tape or 'industry standard' tape).

We shall discuss about each of them shortly but before tha let us uderstand what a tape unit means.

TAPE UNIT:

The magnetic tape unit basically consists of four units:—

1. Tape—the flexible plastic tape with magnetic coating
2. Tape—transport or tape-drive mechanism:— to move the tape. It includes recording and writing heads and the reel on which the tape is wound.
3. Read/write system:— Consisting of reading and writing amplifiers and the 'translators' which translate the tape signals to digital signals for use with the computer and vice-versa.
4. The buffer and switching equipment:— This consists of a buffer device which stores the information from tape and also the informatioin to be read onto the tape. The other facilities reuqired for, such as, rewinding of tape, selection of correct tape mechanism, etc. are also contained in this unit.

(i) Cassette tape:—

The well known home tape-cassette can also be used for cording computer data. These cassettes are small in length &

width (generally about ¼" width), changeable and very cheap. They are the most economic mass storage devices. They are slow, unreliable & have limited data storage capability. They are therefore, normally used for storage of small files on the inexpensive home computers (Fig 8.1)

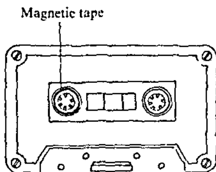


Fig 8 1 Tape Cassette.

To have an idea of their large read/write time, if some data is midway on a 30 minute cassette, it may take 15 minutes just to reach that data with average forward/rewind facility.

The tape-drive mechanism of home cassette is not very good and is not suitable for large business and technical applications. High quality cassettes of same size as home cassettes, with similar appearance and better tape drives have therefore been developed for such applications (Fig 8.2).

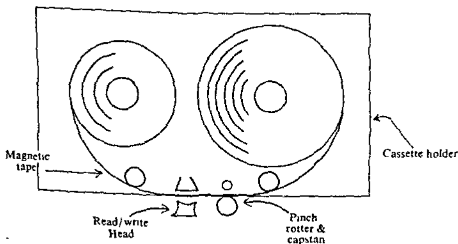


Fig 8.2 Cassette Tape System

(ii) Tape Cartridge

A tape cartridge is a large cassette (tape width usually ¼" same as home cassette) & contains long strip of magnetic tape It is a more convenient way to package a tape. In a conventional reel of tape, the reel is mounted manually and positioned on the drive mechanism like a movie reel is put on a film projector. The cartridge avoids this and greatly simplifies the mounting of tap reels. It also protects the tape from dust & contamination since th tape is permanently sealed in the cartridge.

They have lower storage capacity, but are cheaper & faster as back up devices. Overall, they are high performance mass storage media & particularly good for large back up. Even winchester hard disks are backed up by cartridge tapes.

A number of models for cartridges are available & characteristics vary widely. A high speed cartridge tape unit using ¼", 450 feet tape, can hold 20 Mb of unformatted data. It can store data at a speed of 30,000 bytes/Sec & with density of 8,000 bits per inch. can backup a 20 Mb disk in 12 minutes (Table 8.1).

TABLE 8 1

A Typical Cartridge Tape

Characteristic	Specification
Tape width (inches)	1/4
Tape length (feet)	450
Data Density (bits/inch)	8000
Data Read/Write speed (inches/sec)	3 75
Data transfer rate (KB/Sec)	30K
Storage capacity (unformatted) (MB)	Above 20
Interrecord gap (inches)	1.3
Start/Stop rate (operations/sec)	3 (Max)
Total speed variation (percentage)	± 4 (Max.)

(iii) Magnetic Tape

The magnetic tape used with computers is similar to that used home tape recorders, varying from ½" to 3" in width though,

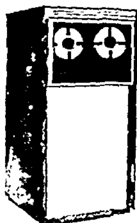


Fig 8.3 A Tape Unit

½" width is most common. The length also varies. A typical 10½" diameter reel would have 2400 to 3600 feet long tape. It is made of plastic that is coated on one side with magnetic oxide (Fig 8.4).

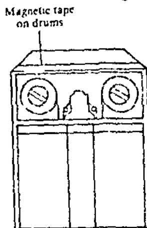


Fig 8 4 Magnetic tape Unit

The principle of operation of an 'industry standard' magnetic tape is similar to a tape used in home tape recorders or a cartridge tape. The information is recorded on the magnetic surface of the tape as sequences of 0s & 1s (bits).

Data are generally recorded on the tape in 7 to 9 parallel tracks (also called channels). Usually, nine channels are used for ½" tape.

The number of characters recorded on the tape is decided by the 'density' of the tape. The recording density may vary from 200 to 12,500 bits per inch per channel. If a byte is consisting of 8 bits & there are 9 tracks on the tape, this also represents the recording density in bytes/inch.

Usually one character is stored in one row along the width of the tape. The information is recorded in blocks with gaps in between the blocks. Stop and start characters are added in each block to signal the beginning and the end of the block. (Fig 8.5)

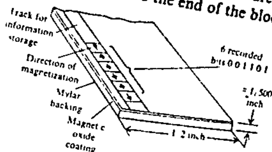


Fig 8 5 Megnetic Tape

Table 8.2

A Typical Magnetic Tape

Characteristic	Specifications
Number of tracks	9
Read/Write speed	45 inches/second
Data Density	1600 bytes/inch (8 bit/Character)
Data transfer rate	72,000 characters/Sec (Max)
Tape reel diameter	10 5"
Tape thickness	1 5 mil
Tape width	½"
Tape length	3000 ft
Start/Stop times	8 33 milliseconds at 45 in/sec

The information is recorded on the tape using a coding system. The coding system varies widely.

Let us discuss the IBM codes. The IBM standard tape is ½" wide and information is recorded in 7 or 9 tracks (See figure). In the 7 track code, 0s are left blank and 1s are indicated by vertical

ADVANTAGES OF TAPES :

High storage low cost:—

Magnetic tape is the most popular storage device for storing large information. Data are stored much more compactly on magnetic tape & is much esaier to handle than say on punched cards. A tape is reusable and therefore cheap whereas punched cards not being reusable are costly. Modern techniques have further reduced the cost hence, vast information can be stored at low cost.

Rugged:—

Magnetic tapes are less sensitive to shocks, dust, and magnetism than hard disks but should still be treated delicately.

Reusable:—

It is not necessary to erase a tape for recording new data. The recording process automatically erases old data when new data is written. This also makes it possible to use the same tape again & again unlike, say paper tape or punched cards. Also, data stored on a tape does not fade away with time so data once stored may be used again and again.

Reusable drive-mechanism:—

Reels may be changed as per requirements so, same tape handling mechanism and associated circuitry with different tapes of different data can be used.

Tape vs Disk:

Compared to disks the tapes have some disadvantages, such as:—

1. Large acces time:

Tapes have a disadvantage in that the information on a tape has to be accessed sequentially compared to disks where access is randomly.

The winding/rewinding of tapes is slow. In a tape, one has to start at the beginning and read through the reel until one comes to the record needed. Also, it is not possible to change part of the

Table 8.3
Comparison of various tapes & disks

	Magnetic Tape	Magnetic Disk pack	Floppy dsik	Cassette
Capacity	Large	Enormous	Much smaller	Limited
Access	Serial	Random	Random	Serial
Access speed	slow	Rapid (50ms)	Slow (200 ms)	Slow (minutes)
Data transfer rate	Slow (100KB/Sec)	Rapid (500KB/Sec)	Slow (50KB/Sec)	Very slow (150B/Sec)
Mean time between failures (hrs)	5000-7000	10000- 12000	1000-1500	Less than 1000

data at a random location on the tape. Disk is much more convenient to use because the head can be positioned on any track and sector to acccess the required information diretly.

The access time of disk storage is a fraction of the access time of a tape. The access time for a disk is less than 0.001 sec whereas for a tape it may be as much as 10 sec. Disk storage is particularly efficient when a comparatively small information on a file is to be frequently updated/retrieved.

Tapes being slow are therefore not suitable for high speed storage for large or medium computers & even microcomputers, execpt for special applications such as backing-up of data. They are generally used only for storing large amount of data economically and for transfering data from one computer to another.

2. Less durable

Disk storage is much more durable than tape storage. Data on a disk are less likely to be lost because of mishandling or a poor storage environment.

However, the disk has some disadvantages over a tape.

1. Expensive

Disk storage is more expensive than magnetic tape. For example, a disk pack costs 20 times as much as a reel of tape with the same storage capacity.

2. Operation difficult

A disk is heavier and more difficult to replace than a reel of tape. When a number of files on different disks are to be processed and disks transporated from one place to another, the time gained in data access may be lost in file replacement time.

Use of Cassette Tapes

Quality: The reliability of data stored on cassettes depends on the quality of the tape used on the cassette recorder. One need not go for the most expensive tape, but average quality would do. In case of a low quality cassette, a 'double recording' technique can be useful This records each program or file twice on the same tape. If it becomes impossible to read the first recording of a file from the cassette, chances are that it will be possible to read the second recording correctly.

Length: One should use short tapes. Longer tapes put more load on the cassette recorder's motor. Also long tapes take long time to wind & rewind Thus, access time to the data recorded is increased Also, due to long rewinding time, it would take you longer if you want to record on the other side.

Number of Programs: As much as possible, you should store only one program on one side of the tape. Recording more than one program can cause two problems. First, the cassette system does not have a reliable way for searching a program quickly & second, overwriting is possible i.e., one is likely to record a new program over the end of a program already recorded.

Write Protect: Cassettes are generally provided with a write/protect notch on the backside. It is not possible to record on the tape if this notch is pushed in. This protects the information on the tape from accidental overwriting. You should ensure that the notch is put properly after the work with the cassette is over.

Selecting a Cassette Recorder

The following features in a Cassette recorder are important for using with a computer:

1. Forward & Reverse Control: A recorder should have a fast forward & reverse control so that the time taken to reach particular information on the tape is minimum.

2. Good Motor: The movement of tape is caused by a motor. Stability of tape speed is very important in computer since they are very sensitive to speed variations. The tape speed varies mainly due to variation in the speed of the motor. Thus, a good quality motor with stable speed is very essential in recorders.

In a cassette recorder used for playing music the advanced models are costly due to the need for higher quality speakers & amplifiers so that music produced is of high fidelity (Hi-Fi). But for a cassette recorder for a computer, the extra cost should not go into speakers & amplifiers, it should rather be invested in the tape transport & motor.

3. Good Counter: The counter helps in locating a program, if there are more than one programs on the tape. An accurate counter would locate a program accuratley.

4. Tone Control: Computers record data on cassettes by changing data in computer memory to a pattern of tones. Two tones are

often used, 1200 Hz & 2400 Hz. The recorder should be able to reproduce only these two tones correctly, unlike in music-recorders where number of tones have to be reproduced correctly. A good tone controller would assist in data loading onto & saving of data from the computer more reliably.

5. **Volume:** The recorder should have flickering indicator lights to indicate levels of recording volume. Many computers are sensitive to the output level used on the recorders. Therefore, a note of volume level should be made above which the computer is intolerant.

6. **No Batteries:** The batteries get discharged after long use which would affect motor speed which in turn would fluctuate the tape-speed. Thus, as far as possible, one should use AC Power with recorders.

7. **AUX/MIC:** A microphone input (MIC) on a recorder is used for weak signals. Similarly an auxiliary (AUX) is used for strong signals. Depending on the strength of the signal, some computers may require MIC & others AUX so, both the inputs should be provided with the recorder.

9

Mass Memory and Storage Devices—Floppy Disks

Floppy Disk

One of the most widely used media for recording computer data is called a floppy disk also known as a diskette, mini disk, or just plain floppy. The terms floppy, floppy-disk, diskette, etc, are used interchangeably. The term floppy refers to the disk's flexibility.

It was developed by the IBM. It is the most common mass data storage media for small computers. It is a very convenient way to feed new software to a micro & to transfer data or software to other micros. The cost of the floppy is very low, about the same as the cost of a tape cassette.

To have an idea of the storage capacity of a floppy disk; a single-sided floppy disk will store approximately one-half as much information as one cassette tape One side of a floppy disk holds as much information as approximately 3000 punched cards. Information can be retrieved from anywhere on a floppy disk in less than half a second, so retrieval than is considerably faster than from a cassette.

Construction:

The floppy diskette is constructed of mylar material and is coated with magnetic oxide, the same material as found on familiar ½" & ¼" magnetic tapes. Data is recorded on the magnetic coating of the diskette.

Unlike magnetic tape, in which narrow strips are wound on reels, floppies are roud disks, 8" or 5¼" or 3½" in diameter with a hole in the centre, giving them the appearence of 45 RPM records. The round hole in the middle of the disk allows the disk drive to hold the disk & spin it.

Unlike magnetic tape, floppy disks are coated on both sides magnetic material which has the advantage of ensuring that

the disks lie flat on both sides. The two sided coating is also advantageous in that, it allows future expansion of the recording system.

Jacket

Unlike the records, the floppy disk is permanently enclosed in a flexible square plastic envelope called the jacket The inside of this jacket is covered with a special non-woven, low-friction fibre to permit easy rotation of the disk, at the same time providing continuous wiping or cleaning action for the disk surface, by trapping dust particles.

Apart from protecting and cleaning the disk, the jacket has number of other roles such as, allowing acçcess to the disk-drive motor and sensors. These are achieved by a number of openings in the jacket

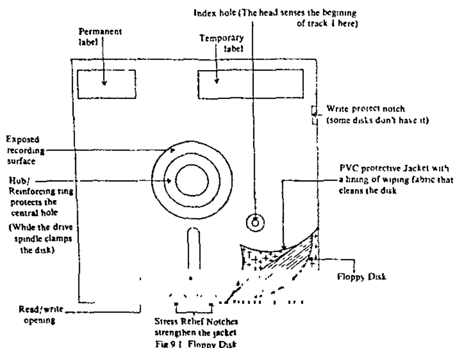


Fig 9 1 Floppy Disk

Disk-Hub

The jacket has a hole in the centre, also called disk-hub. It allows the spindle of the disk-drive motor to firmly grasp and spin the floppy inside the jacket at high speeds.

Access slot

There is a oblong shaped large slot opening called 'access slot' through the jacket. This allows the read/write head of the disk-drive to come in contact with the floppy and read from and write onto the surface of the disk.

Index hole

This hole in the jacket is used to mark the position of the first sector. We would discuss about it more when we come to read/write mechanism of the disk.

Alignment and strain relief notches:

The jacket has these notches to align the floppy properly and also to relieve any strain or stress developed during minor adjustments. These notches generally face towards the rear of the disk-unit

Write protect notch

Diskettes have a notch on one side of their protective jacket which allows or disallows writing of the data onto that diskette. The notch is optional. On 8" diskettes, this notch is known as a write protect-notch & information cannot be written onto the diskette unless this notch has been covered. Information can't be written when the notch is exposed and the diskette is said to be write protected. When the notch is covered with a small aluminium square, data can be freely written onto the disk.

In the case of 5¼" floppies, this convention is reversed. On 5¼" diskettes, this notch is known as write-enable notch, information cannot be written onto the diskette when the notch is covered. To ensure that an important data or program on the diskette must not be lost by accidental overwriting, you must cover the write-enable notch with a label. When this notch is covered, the write enable sensing switch in the disk drive senses lable and disallows writing of data on the diskette.

Some 5¼" diskettes may be permanently write-protected if their protective envelopes do not contain a notch. Any 5¼" diskette with a notch can be write protected by merely covering the notch with a piece of tape.

Envelope

The disk is generally stored in a disk envelope which protects the disk from damage while it is being handled by the user. Also it keeps the dust and other foreign objects away from the exposed recording surface.

Tracks and sectors

Let us see how the information is read from & written onto a disk. Data is recorded on the disk in binary form as sequences of 'O's & 'I' (bits) and stored as magnetic patterns along concentric circles.

Like a book is divided into chapters, and pages are numbered for easy access to any topic by the reader; to facilitate the process of searching for data on the floppy disk, its surface is divided into what are called as 'tracks' and 'sectors'. The main advanatage of dividing the diskette surface into tracks & sectors is that the access time is considerably reduced.

Tracks are a series of concentric circles on the disk surface. To further reduce the time necessary to search for a particular data item, each track is divided into sectors.

Information is stored in sectors along the tracks. At the time of reading/writing, a whole sector is read/written. All the data on the disk is identified by a sector & a track number. Each track is accessible by moving the read/write head along a radius of the disk.

A 5½" floppy may have 35, 40 or 77 tracks per surface. More the tracks, more the information a floppy can store. A 35 track floppy will store about 5 to 10K less data than a 40 track floppy.

The number of bytes stored in a sector is generally independent of track position. This ensures that the data transfer rate is independent of track position even when the outer tracks move faster than the inner tracks.

Each individual sector in IBM floppy holds 512 bytes of data. When the Disk operating systems has access to the track

and sector where a particular data item is being stored, it will only have to search 512 bytes to find that item

Read/write head

The read/write head of the disk drive is like the head of a taperecorder & operates in the same fashion. The head is applied against the disk surface, while a felt pressure pad is applied against the other side. The head actually touches the surface of the disk during these operations. Any defects in the disk surface, such as dirt or creases, will thus cause loss of information. (Fig 9 2)

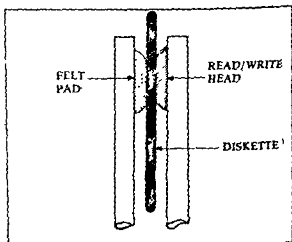


Fig 9 2 Read/Write Mechanism

When a disk drive or the head is misadjusted or when the head is dirty, the surface of the diskette may be damaged, causing appearance of shiny rings on the surface of the diskette. The user should constantly inspect his disk for such damages.

A particular track on a disk is located by the movement of the read/write head to the position of the disk where the track is situated, much like the needle on a phonograph is positioned to the location of a specific song on a record. Locating a track is quite simple but locating a particular sector is quite difficult. A sector is located with the help of 'index' holes (Fig 9.3).

Index hole

The Index hole is a small circular hole in the plastic jacket near & to the right of the large central hole in the middle of the isk. There is also another hole or a number of holes depending

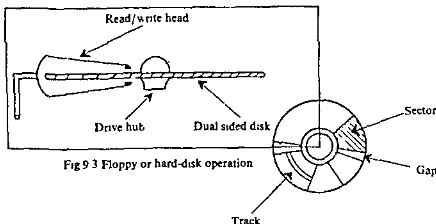


Fig 9 3 Floppy or hard-disk operation

on the formatting of the floppy, through the disk itself. When the disk rotates, the index hole in the disk passes between the hole in the disk jacket. The index hole is lined up with the hole in the jacket and it serves as an index to signal the beginning of recorded material on the disk.

A light source inside the disk drive shines light on the area of the disk containing the index hole. When an index hole on the disk is beneath the index hole on the jacket, the light shines through a sensor. The sensor relays the information about the location of the index holes, which is then used to calculate the location of various sectors

Disk directory

The computer knows the location of each piece of information on a disk drive by reading the directory of the disk. The disk-directory is similar in concept to the label on a LP record. The lable tells you which song is located where on the record.

Size, Side, Density & Sectoring of floppy disk:

Floppy disks come in many varieties. They can be divided in 4 categories depending upon their physical make up:

1. Size -5¼", 8", 3½" diameter
2. Number of sides — Single sided or double sided
3. Recording density — Single or double density
4. Sectoring technique — hard sectored or soft sectored.

Each type requires a specific disk-drive so, it is essential to know which type of disk is compatible with your disk-drive so that you buy the right type of disk.

1. Size

Diskettes come in three sizes, 8", 5¼", & 3½" The 5¼" disks are most popular. IBM-PC uses 5¼" diskette. The 3½" floppies are the latest introduction. The 8" ones are on their way out. The 8" diskette is called a floppy disk, flexible disk or a diskette; 5¼" diskette is known as *mini-floppy* or mini diskette; the 3½" as microfloppy.

There are other sizes including 3", but only a few computers offer disk-drives that use these sizes. The 8" disk drives are decreasing in popularity, mainly because new technology permits the 5¼" disks to store much more data compared to earlier models, as much as four or five times. However, manufacturers are increasingly adopting 3½" floppies which are easier to handle and also permit buliding up of more compact computers that occupy less desk space. The 3½" floppies have another advantages in that they are less prone to damage, the reason being that they are totally encased by a rigid plastic covering whereas conventional disks are covered by an envelope which is not only easy to bend but also exposes more of the magnetic part of the disk to the outside.

2. Sides

Diskettes may be designed to be written on only one side or on both sides. When only one side of the disk is used to record data, it is called single sided (SS).

Sometimes, both sides are used to record data and this type is called double-sided(DS) diskette. Disk drives that use both sides of the diskette, naturally have a larger capacity.

Double sided floppies

The subject of recording both sides of a floppy disk was controversial one, until recently.

It was mentioned earlier that floppies are magnetically coated on both sides so that they have the physical capability of accepting recording on both sides. It would appear very simple then to flip the disk over, just as we do with a LP record, in order to make use f both sides. Unfortunately, the comparison to a record ends e.

It was also mentioned earlier that inside the jacket surrounding the floppy disk is a special wipe material, to provide a continuous cleaning action for the disk, whenever it is in motion. When one side is being recorded or read, the rotation action is always in one direction and contaminents are collected on the inner wiping material If that same disk is then turned over to record or read the other side, this 'other side' revolves in a direction opposite to the direction in which it had moved when it was the 'up side'. As a result, the contaminating material is pulled in the opposite direction by the rubbing action of the disk. This back-flushing action has a great danger of loosening & dislodging of that old debris. This debris can be redeposited on the disk's surface & also cause disk failure.

IBM has solved this problem by introducing a system that permits recording on both sides of the floppy disk. The system, the IBM 3600, uses two heads, one above and one under, to engage both sides of the floppy. By using this method, IBM has avoided turning the disk over and eliminated the possibility of any damage when the disk rotates in reverse direction.

3. Density

Density refers to a diskette's recording format, which in turn decides its capacity. Data may be recorded on diskettes in either single or double or quad density. Double density system records the data more densely or tightly on the disk, increasing (doubling) its storage capacity. Quad-density system puts even more data on the diskette.

If one is using mixed kinds of floppies, they should be identified carefully. Also when purchasing additional diskettes, one must know which type is required.

For 5¼" floppies; single density have about 94KB capacity per side; double density about 140-185 KB per side; and quad density about 370KB per side

Data may be recorded at the surface of the disk in a single-density format at 3408 bits per inch (bpi) and in a double-density format at 6,816 bpi.

The IBM-PC disk-drive uses single-sided-double-density or double-sided-double-density diskettes, though, they are rated for quad-density. The PC-AT uses disk drive that writes data on both sides of the diskette. It uses double density diskette for its 360KB drives and quad density diskettes for its 1.2MB drives

4. Formatting

One cannot use a floppy immediately after its purchase from the market. A new floppy has to go through a process called 'formatting' or 'initializing' before it can be used.

Some disks like the IMB-PC & compatible disks are however, available ready formatted in the market and can be used immediatley after purchase.

Formatting means putting up information onto the disk as to how it should locate its sector/tracks. A mechanism must be provided so that the disk drive may identify any given sector or any track. The idea is to make it compatible and usable with the operating system being used on the computer.

The formatting, apart from setting the floppy to the correct recording format also checks if there are any defective areas on the floppy which should not receive any information. It is only after all this has been done that your floppy is ready to store information.

The format depends upon the operating system your computer is using. Each operating system records information in its own format. For example, if you are using MS-DOS then the floppv has to have a format permitted by MS-DOS so that the computer can accept the floppy.

One can appreciate the necessity of formatting a floopy by comparing with a stereo system. If a LP record has been recorded at 45 rpm, it cannot be played back at 33 rpm. Similarly a computer will not be able to work with a floppy having a different format. If the floppy is not set to the format your operating system permits, you can neither read from it, nor can write onto it.

Unlike an LP record whose rmp cannot be changed, however, a flopply is flexible. You can wipe off the present format and write a new format onto it. Thus, you need not buy a new floppy for every new format, you can reformat the old floppy and use it.

It is important to note that most floppy manufacturers quote unformatted capacities which are of no use, since 'formatting' process reduces the amount of usable storage capacity. For instance, manufacturer-quoted 1000KB floppy may actually have nly 600KB usable capacity.

There are basically two different formats or ways in which mation is located & arranged on floppy disks:

(i) Soft-sectored format also known as the IBM compatible format.

(ii) Hard sectored format which is further divided into many types, the primary ones being:—

(a) hard sector inner diameter (ID) also called as the 'Shugart type' &

(b) hard sector outer diameter (OD) also called as the 'Memorex type'.

There are some slight outward physical differences in the three formats which make it easy to identify one format from the other by visual examination. We shall discuss about them when we discuss various formats individually.

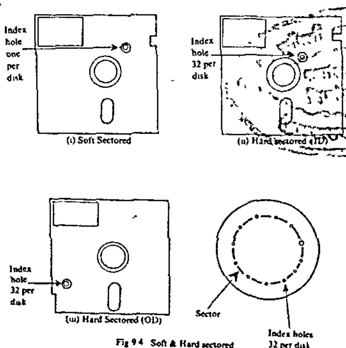


Fig 9.4 Soft & Hard sectored

(i) Soft Sector or IBM compatible format

The speciality of this format is that the disk has only one index hole. This solitary index hole in the disk determines the location of the first sector.

The rotation speed of the floppy disk & the time it takes to arrive from the first sector to a particular sector would determine the location of that specific sector.

In the soft sector format, a num... of tracks, generally 77, are recorded around the disk in concentric circles beginning at the outer edge and proceeding towards the centre. The disk is further divided into generally 26 wedge like sectors.

Each of the track in the soft sector format is identified by a double digit number beginning with 00 through 77. Track 00 at the outer edge of the disk is not used for data recording. The sectors are also assigned numbers from 01 to 26. With 76 tracks in 26 sectors for recording of data, the combination provides us with a total of 76 x 26 i.e., 1976 distinct and discreet recording areas

Each or them is specified by the track number, say,06 and the sector number, such as 15. A zero is used to separate the track number and the sector number, so in this example 06015 represent a unique and complete "address" on the disk where information can be recorded & read till it is either erased or replaced by recording of new information. (the information or data which is recorded or stored at a specific address is called a record). It is important to note that one record is put in one sector with one, two or more tracks in length and only when all the tracks in a sector are over, the record would spill over to next sector & so on

Soft sector disks are normally available in the market already initialised. This means that record indexes have been pre-recorded at the beginning of and at various locations within the sectors so that when the disk is placed in use, the user can simply call the various addresses. This causes the computer or the disk-controller in the disk-drive to move the read/write head to the address called and it prepares the system for either recording of new data or reading of data already present there. The soft sector format simply identifies the method by which prerecorded addresses are used to locate the various areas within a disk where information can be written or read

(ii) Hard sector format

The hard sector formats differ from the soft sector format in two major ways.

(i) The number of sectors employed
(ii) The method they use to indicate the beginning of sectors for accessing various records.

Rather than using written or recorded addresses to indicate the start of a sector, hard formats use a series of holes physically

...or number of sectors/tracks in IBM disks please see "Floppy disk storage ...ty" in this chapter.

punched around the disk. These holes designate the various sectors on the disk.

Rather than 26 sectors, as in the soft sector format, there are 32 holes signalling 32 sectors in both of the major types of hard sector formats i.e. ID & OD

Because there is only a hole and no recorded address at the beginning of each sector in the hard sector formats, there is more room on these types of disks available for the storage of data. Hard sector formatted floppies, thus, allow the storage of more or longer records than do the soft sector floppies.

(ii) (a) The ID hard sector format

This format is quite identical in appearance to the IBM format, except that, instead of just one index hole through the disk, there are 32 holes to signal the beginnings of each of the disk's 32 sectors. An extra hole is used to indicate the location of the first sector The location of the various other sectors is calculated, by counting the number of holes after this first sector.

When viewing IBM and ID hard sector formatted disks side-by side, with index holes in each disk in line with the index holes in the jackets, we cannot tell the difference between the two disks. However, by rotating the disks slightly within their jackets, we can determine if the disk itself has just one hole or more. If there is more than one, then there will be a total of 32, and it is an ID hard sector disk. The other disk with only one hole, is the IBM formatted disk.

(ii) (b) The OD hard sector format:

With the OD hard sector format also there is a small index hole, like ID sector format, but it is considerably further out from the centre of the disk than the hole found in the IBM or ID formatted disks. As with the ID disk, the OD type has a total of 32 sector holes but in this case they circle the disk near the outer edge. These sector holes serve the same purpose of signalling the beginning of each of the disk's 32 sectors.

One other noticeable difference in the OD hard sector disk is a small round cornered "notch" in the lower left corner of the jacket.

TABLE 9.1

Quality Comparison of Cartridge Tape, Floppy Disk & Winchester Disk

Type	Cost	Motion	Requirement of cleanliness	Compactness	Reliability	Exchangeability
Cartridge	Expensive	Stable	Moderate	Poor	Good	Yes
Floppy	Cheap	Unstable	Moderate	Good	Moderate	Yes
Winchester	Expensive	Stable	Very high	Good	Very good	No

Floppy disk storage capacity

Let us examine the formation of sectors & tracks on IBM-disk i.e. the disk using MS-DOS (or PC-DOS). All MS-DOS systems use the same principal for disk layout. For a 5¼" floppy, it varies from 40 tracks and 8 or 9 sectors for double-density (whether single-or double-sided) through 80 tracks with 15 sectors on a high capacity floppy used on PC/AT. Each sector always contains 512 bytes (½KB)

The details about the layout are as follows:

1. A regular floppy has 40 tracks. The high capacity floppy (e g. used with PC/AT) has 80 tracks.
2. There are 8, 9 or 15 sectors in a track. Generally used floppy has 9 sectors. High capacity one has 15 sectors
3. A single sided 5¼" floppy disk thus, has 40 tracks.
   9 sectors per track
   ½ KB per sector
   i e. 40 tracks x 9 sectors per track x ½ KB per sector
   i.e. 40 x 9 x ½ KB = 180 KB capacity.
4. A double sided floppy has
   80 tracks (40 tracks x 2 sides)
   9 sectors per track
   ½ KB per sector
   i.e. 80 tracks x 9 sectors per track x ½ KB per sector
   i e. 80 x 9 x ½ KB = 360 KB capacity.
5. MS-DOS version 1.0 recognizes only 8 sectors per track and accordingly floppy's capacity would reduce to 160 KB & 320 KB respectively for single sided and double sided.

Please note that the statement that a 5¼" double sided, 9 sector-per-track, 40 track floppy has 360 KB capacity is not perfectly correct. In fact, not all 360 KB is available for storage of user information as some space is spent on overheads like disk directory, file allocation table, etc. However, in practice, one generally mentions the full capacity of the floppy.

DISK UNIT AND DRIVE SYSTEM

The term disk-unit is used to mean a drive system & a disk (whether a floppy disk or a hard disk) that stores data on its surface. The disk drive system in turn consists of three units:

(i) Disk controller: The controller is a microprocessor connected to the I/O of the computer. The CPU instructs the controller which in turn directs the disk. It provides a path for information flow between the CPU & the disk. It also keeps the CPU informed about the conditions on the disk.

(ii) The disk-drive itself &

(iii) The software for the disk system i.e. the disk-operating system (DOS).

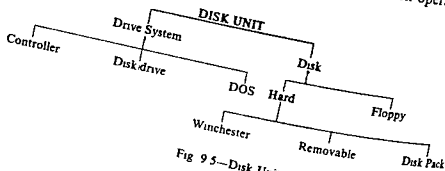


Fig 9 5—Disk Unit

FLOPPY DISK DRIVE

Floppy disk-drives are like cassette players. Like a cassette player plays a cassette, a disk-drive drives a disk. It rotates the disk & transfers information to & from a disk. The information can be transferred from a disk into the computer memory (loading the computer) or from computer memory to the disk (storing, writing or saving). It is quite like recording on cassette recorder & playing back on cassette player. Diskettes do the same job as cassettes except that diskettes do it faster & more reliably.

A floppy disk drive is a vital part of the computer. It is a small metal box with a slot in the front. To access data on a disk, the floppy is inserted in this slot with the label on the floppy uppermost, read/write notch foremost. The disk has a whole in the centre which fits on a spindle which rotates the disk. As the disk rotates, the disk drive moves the read/write head to the desired track on the disk. The head jumps from track to track across the disk to read from or write onto the tracks.

Ordinary disk drives are about four inches thick, but newer es are thin enough about 2 inches, to let you install two thin es in the space where only one regular drive would fit.

The disk drive can store large amount of computer data. For example a single-sided 5¼" IBM floppy disk can store 180 KB data & a double-sided disk can store 360 KB.

SINGLE AND DUAL DRIVES

Most of the software, whether an operating system or applications programs like word processing, database, spreadsheet etc., used on micros, come stored on floppy disks These disks are loaded into the micro before doing any work on it

Some micros have only one floppy disk drive. These micros are quite inconvenient to the user due to various reasons.

(i) Less space· You have less space since the data and programs have to be stored on the same disk.

(ii) Sorting tedious: sorting and combining of data on two separate floppies is very tedious.

(iii) Risky: Since the drives are quite prone to failure, if the only one with your micro goes faulty, you are held up With a dual drive, the chances are that at least one of them would be working If one of them goes out of order, you have time to get it repaired & in the meantime, carry on with the other drive.

(iv) Copying: It is much easier to copy or back up a floppy with two drives. It is no doubt possible to copy disks on a single drive micro, but it is very tedious & time consuming to do so. With only one drive you have to stop in between to change the diskette.

With only one diskette drive what you can do is not limited, however, it takes longer and requires more swapping around of floppies for some operations.

Most micros are therefore provided with two disk drives (dual drive). They are very convenient & useful.

With a dual drive, copying information from one floppy to another is very easy. The floppy being copied is inserted in one drive & the floppy onto which it has to be copied, in the other drive. The copying is carried out in one go.

While running an application program, generally the disk containing the program is inserted in one drive & that containing the data in the other.

The application program like word processing is read from the floppy into the RAM for execution & after it has been read one can take out the floppy from the drive. However,

one would have to reinsert it when one moves from one function to another in the program (e.g. moving from editing to printing in a word processing problem). Therefore, in practice, It is better to have the floppy in the drive so that it can be used by the comput whenever needed.

Some application programs are so long that they need more than one floppy for storage. For running such an application program you have to insert the disks one by one in disk drive & load the program in the RAM of the micro.

A & B Drives: If a micro has two disk-drives, the one on t user's left is called 'A' & the one on the right is called 'B'. They a not labelled like that by a supplier but it is just a convention among the computer users to identify drives in this way. Sometimes, the drives are one above the other in which case the upper & lower drives are respectively called 'A' & 'B' drives.

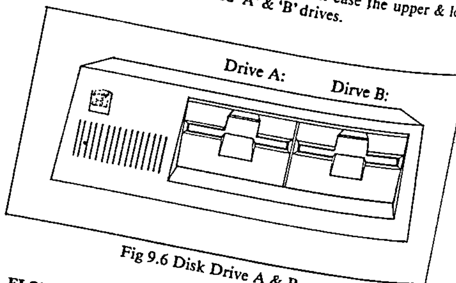


Fig 9.6 Disk Drive A & B

FLOPPY DISK DRIVE SYSTEM AND COMPATIBILITY

There are many options available for a disk drive system. For buying one for a computer, four major factors have to be considered.

1. Compatibility with the hardware.
2. Capacity.
3. Software availability & compatibility.
4. Compatibility with the floppy.

1. Computer and Compatibility

The disk controller together with the disk operating system & the plug & sockets, establishes an interface between the micro & the disk drive. So, before buying a disk drive, make sure that it has the correct interface with your PC.

The software for the disk system i.e., the Disk Operating System needs memory for the storage. Some disk systems store their DOS in the computers memory when the computer is in use. If the DOS needs 16K of memory & your computer also has only 16K memory, there is no place for any other program or data to be processed. With this computer & this disk system, you shall have to buy extra memory & add to your computer.

So before buying a disk system you have to ensure it is compatible with your computer.

2. Capacity

A single-sided single-density 5¼" floppy can store 80 or 90 K of data, double sided double density can store 360 K. You would have to buy the disks & the compatibile disk-system. To be on safer side, after you have evaluated your need for capacity, keep margin for future expansion.

Advanced application may require addition of extra disk drives to enhance capacity. For instance, an application requiring 1000K of data would require at least three disk drives to accommodate separately three double density-double-sided floppies of 360K each.

Most systems allow addition of about four disk-drives without needing extra controller boards or software.

3. Software Compatibility

It is not enough that the disk should use the same hardware interface standard; the software must also be compatible so that the operating system can write information on the disk and read from it. A disk system bought from other than the computer manufacturer may not run the software developed for the standard disk system of the computer. That is, though, the disk drive can be attached to your computer, it is not compatible with the software you want to use. Therefore, before buying a disk system you must ensure that it is identical in function to the standard disk drive for your computer.

For an IBM compatible micro, you have also to consider disk-compatibility. Some compatible micros use disk-drives that store only 160K on a disk. Many application packages for the IBM-PC may not work on such a micro, since they require drives that must store 320K on a disk.

4. Compatibility with the Floppies

It is interesting to note that the type or physical size of a disk does not decide the amount of data it can store. What determines its capacity is the disk-drive. It is unlike the cassettes or records where the storage media used on them sets the storage limit The recorders on which the cassettes or records are played have no role in deciding the storage capacity.

Thus, if two identical floppies are used in two different computers, it is possible that one may store more data than the other because the computers may be using different disk-drives

Similarly, one cannot increase a given computer's disk capacity by shifting over to another type of disk. One cannot exceed the computers, it is possible that one may store more data than the single sided floppy, you cannot increase capacity by using a double sided floppy.

What size of floppies can be used, is also decided by the disk-drive. A 5¼ drive can accept only 5¼ disk & so on.

Thus, the disk drive determines

1 The floppy disk storage capacity.

2 The physical size of the floppy disk to be used on the drive

Let us mention the compatibilities between the types of floppies & the types of floppy-disk drives for an IBM-PC using MS-DOS

The three compatibilities important for them are:

(1) Format compatibility

(2) Read/Write compatibility.

(3) Disk-copy compatibility.

HANDLING OF FLOPPIES

Floppies are like gramophone records. One can record ·rmation on them and also play it back. One has to handle a ... very carefully otherwise its surface may be damaged and

make it unusable i.e. one cannot read from or write onto the floppy. Lot of important information thus, might be totally lost.

Following are the points which one has to follow while working with floppies:

1. DON'T bend or fold floppy.
2. DON'T touch the exposed surfaces of a floppy
3. DON'T write on labels with a sharp pencil or ball point pen. Use felt or sketch pens.
4. DON'T put them in very hot or very cold places.
5. DON'T permit dust inside the floppy.
6. DON'T put floppies near magnetized objects
7. DON'T put diskettes near liquids and chemicals that release vapours.

Labels: Just like a book without a title on the cover is very odd and inconvenient, a floppy without a label on top is not much liked. Each floppy after it contains information should be labelled with a name, consistent with the information it contains. The date on which contents were entered or changed should also be mentioned

Manufacturers of floppies provide sticky labels with the floppies you buy. You should write the name on a label before sticking it to a floppy, otherwise indenting by a pen may cause damage to the floppy, and make it unusable If you want to alter the name after a label has been pasted, use a felt-tip or sketch pen and not a ball point pen

10.

Mass Memory & Storage Devices

HARD DISKS

A hard disk also called a magnetic disk, is a disk made of a hard but light metal machined in the form of a plate. It is an unbendable version of a floppy disk. It is coated on both sides with a magnetic oxide.

Due to its rigid construction, a hard disk can have a more precise read/write mechanism compared to a floppy disk. This gives rise to two advantages.

(i) A hard disk can store much more information than a floppy disk &,

(ii) the information on hard disk can be accessed much faster than on a floppy disk.

Hard disks generally vary in sizes from 5¼" to 12" in diameter and can store information on one or both sides. Even smaller and larger than these sizes are available. 8" disk is normally used with micros. Recently vary compact disks, even 3" are becoming available. The larger the size the more the information the disk can store.

A hard disk stores many times the information even a large capacity floppy can store. The smallest hard-disk capacity is 5MB. A typical hard disk holds 10 to 20MB. Even more than 100MB disks are available for large systems. If still high storage is required, extra disk drives can be added externally to the computers.

A micro with a hard-disk is now capable of doing very large computing jobs which were earlier possible only with expensive computers. If one has a lot of data which should be accessed & stored in one operation than one should use a hard disk.

Apart from high 'on line' storage capacity, another advantage of a hard disk is that it permits convenient operation of program. Not only can one store large data on a hard disk but lso, the operating system & the application programs. If the ating system, application programs & the data is available to

the computer at one plate, it would run the program soon after it is switched on. We say that the booting up is quicker with hard-disk than with floppies. One does not have to load these items each time from the separate floppies. Thus a hard-disk is much more convenient and time-saving for the user.

CONSTRUCTION:

Hard disk generally has more than one platter stacked one above the other (similar to a stack of phonograph records). The stack is turned by a single drive shaft at very high speeds of up to 2400 revolutions per minute (rpm) i.e., 40 revolutions per second.

Both the surfaces of each platter are coated with a magnetic oxide like that on a magnetic tape. Earlier, only one side of the disk was used but the development in technology has now made it possible to use both sides. So the data is recorded on both the surfaces of a platter.

TRACKS AND SECTORS:

On a floppy disk, a track is basically a concentric circle on which data can be recorded (like a railway track on which trains can ply). However, the tracks-as-concentric-circle idea with floppies cannot be applied to disks. They rather have a concept of concentric cylinders of data. A cylinder is a set of all concentric circles with same radii.

A surface of a disk depending upon the model has from 50 to 100 circular tracks along which the data are recorded. Usually, data are recorded serially along a single track.

Generally, for each side of each disk there is a reading and recording head that moves in and out between the disks. It can be located at any point on the disk from where the data item is to be read or recorded.

Each disk face is divided into a number of sectors.

Files and records are stored in storage segment. A storge segment will store one or more records of a file, depending upon the size of records.

Each storage segment is uniquely defined on a hard disk by the segment's face number, track number and the sector number. For example a file in segment (3, 52, 7) means 3rd face, 52nd track and 7th sector. So a particular file/record can be directly accessed

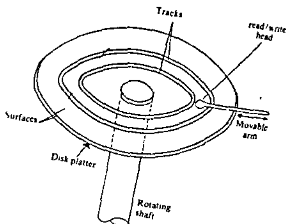


Fig 10 1 Magnetic Disk

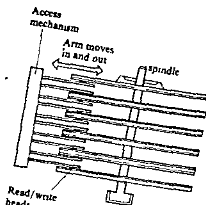


Fig 10 2 Magnetic Disc Drive Read/write mechanism

if its segment is known. Thus, the access time can be very small,a small as 0.001 sec.

Head Per Track Disk

Generally, in the hard disks there is one read/write head for each surface. The reading/writing of information on such disk takes a lot of time. The delay in reading of information is due to the time the read/write head takes to move from track to track on the disk. To avoid this, in some disk units, each track has its own read/write head. The recording heads are thus fixed and the access time is further reduced very much. As the physical dimension of a head is quite large, the number of tracks in such a disk is limited. Also, because the heads are fixed, the disk is not interchangeable.

Head Crash

A hard disk is usually encased in a special protective shell or in a cartridge.

It has a hole in the centre so that it can be put on a spindle and the disk may rotate The disk platter rotates at very high speeds like 2400 revolutions per minute i e., 40 rotations per second The read/write head of the disk does not make a physical contact with the disk surface, it 'flies' over it. At so high rotational speeds, an air-cushion effect is caused so that the head floats on the cushion just above the surface of the disk. If by any chance, the head physically comes in contact with the disk surface, the surface and the head both would be damaged permanently Called a 'head crash', this is the worst catastrophy which a hard disk drive can meet.

TYPES OF DISKS:

Many types of hard disk are available. There are three main types:

1. 'Winchester' or fixed disks.
2. Removable disks.
3. Disk—Pack.

1. Winchester Disk:

Winchester disk was introduced in 1978. It is extremely sensitive to dust, dirt and smoke. Hence, it must be kept very clean. Due to the stringent requirement of cleanlines, it is permanently fixed & sealed in a dust proof enclosure which greatly reduces the danger of contamination. They are lower in cost and performance level than regular hard disks.

Winchester disks come in various sizes. A Winchester has a greater storage capacity than the same size floppy disk. About 6 to 10 times more data can be stored on a Winchester disk surface than on a standard floppy disk. Also it operates faster than a floppy. The smaller Winchester disk drives (8" & 5¼") take up the same physical space as their floppy counterparts. They come out to be cheaper than regular hard disks & because of their low cost, they are generally used with microcomputers.

A Winchester disk has the greatest disadvantage in that , since it is fixed, you cannot remove the disk cartridge from the disk-drive and insert another one. Thus, the overall storage capacity is restricted. Once the disk is filled up, you to copy or back-up on to seperate floppies. Th

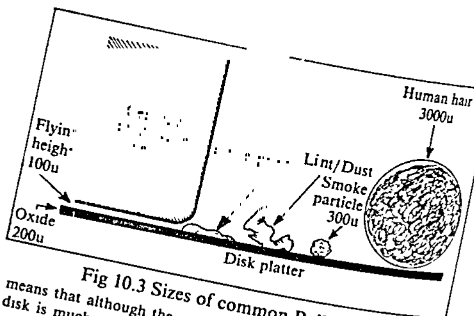


Fig 10.3 Sizes of common Pollutants

means that although the on-line storage capacity with Winchester disk is much greater than with floppy disks, the flexibility is not much improved

Although removable hard disks are more flexible than winchesters, due to high cost they are not used on micros. They are used on expensive computers such as minicomputer.

Since, Winchester disks cannot be removed, a microcomputer with Winchester disks also often has a floppy disk system along with the Winchester disks to allow for back-up storage. This is the case with the IBM/XT. The IBM/XT's hard disk has a capacity of 10 MB. It has the cartridge drive built into the case of the machine. It also has in addition, one floppy disk drive system. Thus IBM/XT has one hard-disk drive & one floppy-disk drive.

2. Removable Hard-Disk

A hard disk can also be packed in a removable cartridge which is not sealed like a Winchester disk. The disk drive & the hard disk are independent units & the user can remove one hard disk & insert another. The handling of the disk in this facility is very easy. It's more expensive than a Winchester disk.

Removable hard-disk systems come in many sizes & capacities. Even the smallest size can hold 5MB of data. The bigger ones can hold up to 40MB.

The advantages of disk cartridges are their small sizes & ease of portability. One cartridge is easily fitted into a small attache .. They are also comparatively cheap. It also permits making of

backup copies & transfer of information from one computer to another.

Cartridges may have different number of sectors. In fact, two cartridges which appear very similar may have different number of sectors.

Dual Disk:

The hard disks are generally available as 'dual-disk' units. This kind of unit has two disks, one is a fixed platter that is non-removable & the second is a removable cartridge.

This has the advantage that important application programs, operating system, etc., can be permanently stored on the fixed platter & the data can be stored on the removable cartridge.

With a dual-disk unit, to transfer files from one removable cartridge to another removable cartridge, two cartridge drives are needed. Alternatively, the files may first be copied from removable cartridge to the fixed platter & then transferred from the platter to a fresh removable cartridge on the same dual disk unit. This would necessitate loading & unloading of cartridge several times but only one dual-disk unit is enough

3. Disk-Pack

Hard-disks are often combined in the form of a stack, one above the other. Several disks (platters) forming such a stack form a unit which is rotated by a single drive shaft. (Fig. 10.4)

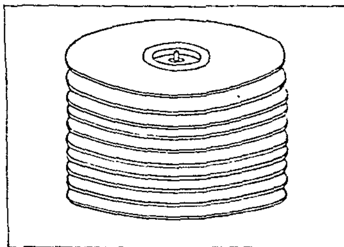


Fig 10.4 The disk pack

Such a stack of hard-disks is called a disk-pack & has much larger storage capacity than one individual disk. They are generally packed with 5 & 12 disks. A typical pack with 5 platters can store 40 to 80 MB. A 12-platter pack may store 100 to 300 MB.

Generally in a disk unit, an individual disk cannot be removed and a new one cannot be inserted. The disk is permanently enclosed in the disk-unit, unlike a floppy disk which can be removed & a fresh one inserted freely in a floppy-disk drive.

However, the whole stack of disks can be removed from the shaft & replaced by a different stack. Such a replaceable pack can store up to 50MB which is about the storage capacity of a magnetic tape of high-density.

Disk packs need to be handled very carefully, more carefully than even a disk-cartridge or a Winchester disk. This is because a disk-pack has a number of platters & even a slight misadjustment between two platters would cause misalignment of read/write head. This may subsequently cause 'head-crash' when the data is read from or written to the disk; & even complete loss of data. The disk-pack should therefore be inserted & seated very carefully.

Hard disk storage capacity .

The hard disk supplied with IBM-PC/AT is a 20 MB capacity disk. Let us see how this figure comes.

1. This disk unit has two rotating disks (platters) within it . Data is recorded on both sides of each platter giving four surfaces. The surfaces are numbered as 0, 1, 2, & 3.
2. The unit has 615 cylinders.
3. Since there are four surfaces in the unit, each cylinder has 4 tracks.
4. Each track has 17 sectors per track i.e. in all 68 sectors per cylinder.
5. Each sector has capacity of ½ KB (512 bytes).

Thus, a hard disk can store a total of 615 cylinder × 4 tracks per cylinder × 17 sectores per track x ½ KB i e., 615 × 4 × 17 × ½ KB = 20910 KB = 20.9 MB

However, this figure is slightly misleading. The reason being that one whole cylinder & four sectors of each of the other cylinders are reserved and are not available for storage of user data. So a cylinder having 68 tracks (4 tracks x 17 sectors per ack) actually stores data on only 64 tracks. Also out of 615

Table 10.1
Mass storage devices — A comparison

	Tape Reel 5" dia.	Cassette (phillips)	Cartridge (3 M type)	Floppy disk	Large fixed hard disk
Capacity (KB)	18,500	550	2500	250	571,000
Data transfer rate (KB/Sec)	180	9 6	48	250	14,00
Number of tracks	9	2	4	77	600
Data density (bits/inch)	880	880	1600	3200	1600
Interrecord gap (inches)	0.6	0 8	1 3	Not applicable	Not applicable
Approximate storage cost ratio (Floppy taken as 1)	0 02	0 5	0 2	1	0 1
Approximate drive mechanism cost ratio (floppy taken as 1)	5	1	1 2	1	75

cylinders, 614 are available for storage. So effective cap available for programs and data is reduced to 614 cylinders o sectors i.e.,

614 × 64 × ½ KB = 19644 KB = 20 MB (approximately)

That is why the hard disk with IBM-PC/AT is called a 20 MB disk.

Back up

A hard disk can store a large volume of information. In case of malfunctioning or an accident all that huge information may be lost. Information can be lost from floppies also since they are very prone to physical damages. Also they are easily 'corrupted' by even smallest amount of dust in the disk drive.

To summarise, you may loose the important information on disks due to:

1. Malfunctioning of the Computer.
2. Loss of disk.
3. Mishandling of the disk like bending.
4. Wrong inadvertent commands like 'delete'.
5. 'Corruption'.
6. Calamities such as fire, flood etc. And so on.

Thus, at any point of time the data on a floppy or a hard disk is likely to be damaged or lost, either by user himself or by someone else having access to the data.

To overcome these accidental losses, the information stored on storage devices like floppies or a hard disk are backed up. The moment any changes are made on a disk, it is backed up & stored at a safe place.

Back-up means making a duplicate copy of the data. The extra copy protects against disk-failures. It has another advantages in that it provides an economical means of transferring data from one computer to another. Back-up is also necessary to creat space in the disk for fresh work.

Number of methods are used to back up but mainly three or four of them are used for micros:

(i) **Floppy back-up:** This means backing up onto one or more floppies from the hard disk. The process is cheap but very slow & umbersome. If lot of information has to be backed up regularly,

it is impractical & very time-consuming. For example, the full operation of back up of an entire 20 MB Winchester disk onto 300 KB floppies may take a couple of hours. Another disadvantage is that more than one floppy are required & they have to be properly labelled in sequence. A particular program or data may have to be split up on more than one floppy. The advantage, however, is that floppies provide the cheapest way of back up & are generally used by microcomputer users.

(ii) **Tape Back Up:** This means backing up onto computer tapes. Now-a-days, it is a common device for storing huge amount of data, & to make copies regularly & quickly. This is the device used by medium & large computer users Tape back up is fast, cheap, & simple. The data on 20 MB Winchester disk can be transferred in a matter of minutes Back up on tapes is cheaper than onto hard disks but slightly costly compared to floppies. However, the tape prices are falling day by day & even microcomputer users find them attractive solutions.

The disadvantages are that tapes can be accessed only serially. It is not easy to search & call specific piece of information from the tape like it is difficult to locate a specific song on a cassette tape. The tapes have to be fitted in the tape-drives, external to the computer, whereas floppies & hard disk drives can be often put within or very near to the computer.

Two main types of tapes are used for back up

(i) 'Streamer' tape.
(ii) 'Stop/start' tape.

The 'streamer' tape can back up very fast but it has two disadvantages. First, it records information in continuous stream irrespective of the number & kinds of files. Thus, if is a 'indiscriminate' type of back up device. As a result of which it is difficult to call a specific piece of information. Second, a streamer some times picks up garbage or stray information from the disk being copied. This makes it very difficult to return the back up data onto anything (say another computer), except to that same disk.

The 'stop/start' tape on the contrary is slow but it breaks up data into individual files which makes it convenient to search/call a specific piece of data. Even if the original disk is lost, the back up copy is as good as the original disk, unlike the back up copy on a 'streamer'.

(iii) **Removable Hard-Disk (Cartridge) Back-Up:** This means backing up from a floppy or hard disk to another removable hard disk. This method is very expensive but very fast. It is like copying from one hard disk to another hard disk, so back up is in the same format as on the original disk. Due to this, it is very easy to find specific files as easily as on original disk, unlike a tape back up Also, in cases where a cartridge disk-drive is already a part of the computer system, no extra drive need to be purchased.

(iv) **Disk-pack back up:** A disk-pack may also be used for back up The storage is very fast & capacity is extremely high. With very large computers, requiring high speed & high volume of data, disk-pack is a practical solution

STORAGE OF BACK-UP COPIES

The back up & original data should be stored at different places & at least one of them should not be very easily accessible. Otherwise, in case of damage of one, the user will be tempted to use the other immediately & may be, this other copy is also damaged. In fact, one should have more than one back up for very important information, each copy properly labelled & stored. You should use a copy for day-to-day use so that if anything happens to it, another copy can be made from the original.*

Some suppliers offer an ordinary video recorder to store back up copies of the information on a Beta or VHS recorder.

Optical (Laser) Disks:

The computers have given us a need for storing huge information efficiently and in less space. Even hard disks have their limits, especially for applications needing data in billions of bytes. With this in mind, a very compact & efficient means of data storage, the laser disk, also called an optical disk, has been discovered.

A laser disk is a recent type of data storage device for storage of very lafge volume of information. They are presently very costly

* Some application programs on floppies (like Visicalc) are copy protected, that is, the manufacturer has made the floppy in such a way that you can not copy it. Such floppies mention copy protection on the labels so that you know whether you copy it or not Leaving aside such exceptions, if you can copy your application grams, you must back up

and affordable only by large computer users. However, research and development is causing gradual decline in their prices and it is not very far when laser disks would have wide popularity even among the microcomputer users The laser disk is the disk technology that has a great future.

These disks are similar to the ones used in laser disk video and audio systems. They are plastic disks into which the information is put in the form of bits ('0's & '1's).

A laser disk uses light in the form of laser to write and read data. The laser records information by focussing heat that creates a small bubble (or 'burns' a hole) on the disk surface to indicate a binary digit. For reading the disk, light is bounced off the disk. If the disk has information stored on it (i.e. if it has a hole at the site being read) the angle of the reflected light would change and thus, the data recorded on the disk is read.

The advantages of a laser disk are:

(i) Huge Storage:

Huge amount of information compared to disks and floppies can be stored.

Because of the precision with which laser beam can be controlled, the bit density of storage is very high. The storage capacity of an optical disk of 12" diameter may be about 1GB i.e., a billion bytes. A 5¼" magneto-optical disk from 3M Corporation can store 300 to 550 MB i.e. about 25 hard disks of about 20 MB each or 1500 floppy disks of about 300KB each.

Large computer users like libraries have already taken on to laser-disk storage in place of microfilms used earlier.

(ii) Simultaneous storage of data picture and sound:

The impressive high storage capacity of a laser disk permits the storage of voice, picture & data on just one disk.

(iii) No back up required:

The information on the disk is virtually indestructible, so that it is not necessary to keep a back up separately.

(iv) Future of networking & electronic filing system.

Research is on to design equipment which can access hundreds of laser disks. This would make it possible to store millions of

documents inexpensively Combined in a local area networ
an electronic filing system, it would place staggering amou
information within easy access of any terminal.

(iv) Optical disks are less fragile than magnetic media, & they
easy to use.

(vi) Erasable:

By now there are three different types of optical disks ava
lable which combine laser-optical-magnetic technology:

1. Read only. The user can read but cannot write on the disk
2. Write-Only The user can write once but cannot write again. He cannot erase anything that is written.
3. Erasable: They can be used for recording, erasing, reading, re-recording the data. Presently in developmental stage. Once fully feasible, it will give a tremendous boost to the use of laser disks.

Disadvantages:

(i) The major problem is that the information once written cannot be erased. So the laser disk cannot be used second time unlike a hard or a floppy disk or a tape. The hole once burnt is a permanent record. However, research is continuing and this barrier may be overcome.

(ii) The laser disk is presently very expensive. However, if the disk can be used to its capacity (Min 100MB) the cost per kilobyte generally works out to be lesser than the conventional storage devices. Also, the technological developments are underway to drastically reduce the cost.

11.

KEY BOARD

Keyboard is the most important aspect of a computer, & this is what that makes a computer 'personal' in the real sense of the term.

The CPU of a computer can understand only electronic signals. The keyboard is the bridge between the operator & his computer system.

It is the main device by which data is entered into the computer. The user communicates with the computer by typing instructions & pressing keys on the keyboard.

The Keyboard Quality

The keyboard quality varies among various models of computers. If you would be using your micro for sufficiently long however, it is difficult to have a consensus on what constitutes a the keyboard quality & layout are very important considerations.

Micros are available with all sizes & types of keyboards, however, it is difficult to have a consensus on what constitutes a good keyboard. Opinions would differ due to many subjective 'senses'. The perception of a 'good touch' is dependent on an individual.

In spite of lack of absolute objectivity, some keyboards are certainly better then others.

1. The Material

(i) Membrane type keyboards: These keyboards are made of continuous & flat plastic sheets. The characters are marked in the same layout (OWERTY) as they are on a conventional keyboard. An electric connection is made by pressing the key-marking on the plastic.

These keyboards are inexpensive but are difficult to use for two reasons First, a firm pressure has to be applied on keys to ensure that they are 'registered'; second, one has to press at just the right place, failing which the key will not 'register'. So, one has

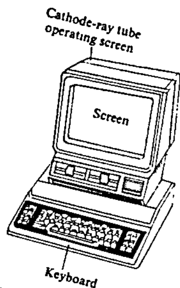


Fig 11.1 Keyboard input

to type carefully, slowly, & check after each character that itis registered. Indeed, a very laborious work for long texts

(ii) Rubber or chiclet style keyboards: Instead of a continuous flat plastic sheet as on membrane keyboards, these keyboards are made from rubber which is stamped into key shapes. If you look at the keys from the top it appears as if each key is separate, like on a conventional typewriter but, in fact, all the keys are joined together at the bottom. Pressing of a key makes electric connections, like in case of a membrane-key. On these keyboards also, keys have to be pressed correctly at the centre, & also firmly, otherwise one may miss the connection. Like membrane keys, one has to be slow & careful on 'rubber' keys also A maddening affair for any operator.

They are a shade better but smaller than the membrane keyboards. They offer resistance to touch & produce a soft 'pop' when you remove the finger. Tolerable for game applications where they are little used but not suitable for applications involving lot of use of the keyboard.

2. Size

Some Electronic typewriters may have keys which are very compared to conventional typewriters. Also, they may be

crammed together which makes it very difficult to type fast. They are prone to making errors One cannot touch type on such midget-sized keyboards.

3. Shapes

Some keyboards have dead-flat keys. Some have convex button like keys. Some others have concave or dished keys.

(i) Flat Keys: With flat keys, it is difficult to hit right at the centre of the keys, during fast typing. Sideways hitting may not make electric connections.

(ii) Convex Keys: Convex keys are protruded out from the centre. They are positively uneasy to use since there is every chance of slipping of fingers during fast typing & you may miss characters.

(iii) Dished Keys: The best are the dished keys. If they are also large, nothing to beat them. A dished key has a dip in the centre, technically called a concave-top. This helps the user to locate the keys easily & also hit right at the centre. Any slight-side-ways hitting will automatically try to bring the finger in the centre.

THE KEYS & FUNCTIONS

The keys on a computer keyboard can be divided in five categories, depending upon the kind of jobs they perform:

1. Character Keys
2. Programmed Function Keys.
3. Programmable Function Keys
4. Cursor control Keys
5. Numeric Keys

1. Character Keys: Character keys are the same as found on ordinary typewriter. They consist of alphabets, numerals, punctuation marks & some special symbols; apart from keys like spacebar, shift key, etc.

Some keyboards have some special symbols like $ etc. You should opt for a model which has special symbols of your choice. A few computers may generate only upper-case letters & not lower-case ones. Do ensure that yours can create both.

2. Programmed Function Keys: The keyboards have 'function' keys to help you to perform many jobs automatically just by one

Their jobs are not predefined by the computer manufacturer but can be altered as per the application software being used. For example, a particular key might be used to delete a word on a word processing package, but with a communication package it may be used for redialling a telephone number.

Some computers permit even the user to assign his own functions to some function keys. For instance, you may assign 'printing of a program' to a function key. Each time you press this key the whole program will be printed by the printer.

Microcomputers generally have 10 such programmable function keys. Each key is used by the user to allot a frequently used operation, to save time by pressing only that key & not enter the entire instruction corresponding to that key.

The programmable keys also make it convenient for a beginner to learn the use of computer.

4. **Cursor-Control Keys:** An important feature of most of the computer keyboards is cursor control keys. They permit the user to move the cursor on the screen. Some computers do not provide these keys. The cursor movement with such computers is achieved by pressing of the control key & some other key together.

These keys should be placed properly on the keyboard since they are often used keys. Ideally, they should be on the right of the user where they can be used easily. Some keyboards put these keys on the numeric keypad in which case the keys serve both functions. You can select the function you want them to perform by pressing another key or a switch. For instance, in numeric mode, the keys permit data entry & in cursor control mode, they permit cursor movement. Some keyboards have two cursor keys, one for left/right & the other for up/down movements. The pressing of left/right key may move the cursor to left & if right movement is desired, you would have to press left/right key & the shift key together. The best keyboard is the one which provides four cursor keys, each movement, left, right, up & down can be controlled by one keystroke.

5 **Numeric Keys:** Some keyboards have a numeric keyboard along with the basic keyboard The digits from 0 to 9 are provided at one place like on a calculator, normally to the right of the user, so that if you have to enter a lot of data in the computer, you can do it more easily. The fingers would need less movements & bending A lot of time is saved in data entry compared to the time

you would take with an ordinary typewriter with OWERTY arrangement, where the number keys are in top one row. It is very cumbersome & tiring to enter heavy data with the keys in one line.

Number of Keys

The number of keys on the keyboard varies from model to model Some may have as few as sixty keys, others may have even above a hundred The more the number of keys the more the functions which can be provided by a single keystroke & hence, the easier it is for the user

For instance, on a keyboard with insufficient keys, you might have to hold the control key &, say, the 'I' key to insert characters in the text already typed A keyboard with large number of keys may provide an 'insert' key that performs the job of insertion with the pressing of a single key

Layout: The central part of a computer keyboard is very much like an ordinary typewriter keyboard, known as OWERTY arrangement of letters, numbers, spacebar, shift keys, etc. These standard keys are often nearest to the keyboard operator so that he can reach them most easily. The keys on the extreme right & left are used to perform special jobs These keys are sometimes used alone and sometimes in conjunction with other keys.

The adoption of this standard layout means that you can become an instant expert on a computer keyboard if you are the one on an ordinary typewriter. Transferring from ordinary typewriter to computer key-board will be very easy for the person familiar with typing.

The various models, however, do have some differences in the overall layout which is caused by the extra special keys & functional keys provided with the keyboards The total number & functions of such keys vary enormously from as little as ten to as much as forty.

Function keys may be arranged in different ways They are generally grouped on the keyboard according to the type of jobs they perform The most used function keys are provided within the easiest reach of the operator

Position of some of the special keys on the keyboard is very important. For example, some keyboards have frequently used

keys like the cursor control keys at positions not easily approachable. These keys, normally marked with arrows, & others like delete keys should have positioning for easy approach since, they are often required during text edition. Keys often used in combination should also be so placed that all of them can be easily searched & accessed.

Drastic Keys

The functions of the keys on the keyboard is decided by the application programs being used & vary with different programs. Some keys are 'drastic' in the sense that hitting them by mistake might cause catastrophic damage such as wiping out the whole file and it may be difficult to restore the original position

Control keys are generally operated in conjunction with other keys. Sometimes, pressing the wrong control key may cause great damage. Therefore, the control key should be clearly distinguished and labelled. Also, it should not be very easily accessible, to avoid pressing by mistake while other keys are being used. If the control key is near to the often used 'shift' key, the user is quite likely to press the 'control' key inadvertently, when he actually means to press the shift key Similarly, a 'delete' key just next to a frequently used key can cause a catastrophy by erasing of everything in the computer memory. The other drastic keys like 'break', 'clear', 'relocate' etc. should be a bit apart from the keys used frequently & also they have to be remembered and handled carefully.

The keyboard should indicate through steady or flickering lights, whenever drastic keys & keys like 'caps lock' (used for continuous typing of uppercase letters) are on. This permits the operator to be watchful & remove the 'lock' when uppercase letters are not desired.

Repeat

Generally, all the keys on the keyboard of a micro are typematic which means that a key will repeat if it is kept pressed. If a finger is kept on a key,after a little pause, the key sends a series of signals, all repeating the character on the key. Normally the rate of repeat increases after sometime. The repeat feature is particularly very advantageous on cursor keys, since large cursor movements may be required during editing of the text. Some keyboards have repeat feature for a few keys only, whereas some may have it for almost all keys. It is good to have it for maximum keys. However,

the user should be careful to see that, when not required, fingers are not kept on keys by oversight. Otherwise it would keep typing a row of undesired character. To overcome this, most of the keyboards with repeat key feature, give enough time-duration between typing of first character & its repetition so that, if you keep the key pressed for a time within this interval, the character would not be repeated Only when you cross this time-limit, would the key repeat its function.

Angle

Another variable feature important with the keyboards is the 'rake' which is the measure of the angle at which various rows of keys are placed Ordinary type-writers are steeply raked but computer keyboards are comparatively flat; some are almost flat. In fact, with practice, you would discover that flatter keyboards are easier to work upon, since you have to move & bend the fingers less than you do on a steeper keyboard. Long use of flatter keyboards causes less fatigue.

Feel

The 'feel' of the keys on a computer keyboard varies in different models. In fact, you may find the touch of all of them quite strange, if you have been working with conventional type-writers You might find it difficult to adopt to a 'soft' touch the computer keyboard requires The keys on the computer keyboard don't require the same firmness of touch as in manual typewriters.

The pressing of a key sends an electrical signal to the computer which in turn causes a character to be displayed on the video screen if the computer has been connected to one

The keys on computer keyboards have a tactile feedback which means, every time one presses a key, a firm click sound is heard. If this sound is not there it implies that the key has not been registered. It is a very necessary feature on micros since it reduces typing errors drastically. For instance, the error of 'dropped character' is eliminated to a great extent.

Compared to an ordinary typewriter, the 'feel' on computer keyboard may be 'clattery' & 'hollow' At times, you may even doubt whether a key-press has really been registered. In fact, to - this, some keyboards are linked to a beeper which gives a und everytime a character is registered. However, after a

practice of an hour or two on the keyboard, you would start liking the 'soft' touch much more than the 'hard' touch on ordinary typewriter keyboard In fact, you may not even like the continuous sound from the beeper & can put it off, once you are psychologically sure that all characters are getting registered.

Key Bounce

A good keyboard should be firmly mounted with no flexing. The keys should offer smooth resistance to the fingers without catching them. Keybounces should not occur. A **keybounce is** that when you type 'p' on the keyboard, actually 'pp' or 'ppp' appears on the screen. This happens if contact is not immediately released after the finger has been removed. Dust, rusting etc. cause this problem.

12.

Monitors

Video Display:

Generally, a microcomputer is provided with a television or a television like tube on which characters or graphics are displayed.

The display is called by different names such as monitor, console, CRT (Cathode Ray Tube), VDU (Video Display Unit), terminal, or screen. Even a home TV can be used to display. Whatever the name, its function is to display.

The input medium for a computer is a keyboard. What you type on the keyboard is displayed on the video. The video also asks you questions, & gives you instructions. The user needs the display, so that he knows what all is going on. Without it, he will not know what he is typing. Though display he can 'talk' to his computer. In fact the communication is two way, the computer can also 'talk' to him. Though the computer for its functioning does not need a display, it is a necessity for the user.

A video is a primary means of communicating with a computer. It may be thought of as a window to the computer's memory. It displays whatever is already there in the memory or is freshly entered through the keyboard. However, the user can only see the amount of data the screen can display at one time. The software allows scrolling the screen up or down to see data not appearing on the screen but stored in the memory.

Generally the display is purchased separately. One can use home TV also, you will have to connect it to the computer through an adapter called 'RF modulator.' Some micros such as Eagle II, Keypro II, Commdore, etc. have built-in video display. Others like IBM-PC, Apple II etc. have to be connected to a video display separately. They, however, have the circuits for controlling the video display, only the display unit has to be connected separately.

The keyboard & the CRT terminals may be separate units connected to each other via a cable or may be indirectly connected to each other via the computer. In a PC, the keyboard is [illegible] to the input, & the screen to the output portion of the

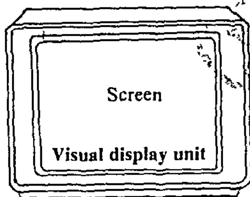


Fig 12.1 Visual dispaly unit

computer. A character typed on the keyboard, via the computer, is displayed on the screen.

The number of lines a computer can display at one time and the number of characters on a line are important factors in an application.

Monitors come in various sizes. Some inexpensive computers display 12 lines of text, each line of 32 characters or less. A standard screen display for small computers measures 12" diagonally & can display either 24 horizontal lines (rows) of 40 columns, or 16 lines of 64 columns. IBM-PC monitor can display 24 lines of 80 characters each. The display size is represented by number of columns by number of rows, such as 80X 24 for IBM-PC. This means that a maximum of 80 characters in one horizontal line can be displayed. Most monitors can display both upper & lower case letters.

Monitor VS TV

Screen displays or video monitors appear like TVs but they are not the same as TV sets.

Among the TVs & other display devices, video monitors offer the best display. This is because the monitors are specially designed for use with the computers & therefore, they display much superior quality of pictures compared to those offered by TVs. Where a computer is used for graphics, the quality of the monitor becomes even more important & TVs may not be suitable.

Unlike a TV however, they cost high. Industrial grade monitors like the ones used in airports cost very high. Inexpensive

monitors, colour as well as monochrome, for general purpose applications are manufactured by large number of manufacturers

Except for being cheap, TVs have a number of disadvantages over video monitors. Some of them are:

(i) TVs have annoying 'interference', which is almost non-existent on monitors. The interference in a TV is due to the RF modulator, particularly the cheaper ones, used to connect the TV to the computer.

(ii) On a TV, colours appear washed out but are sharp & brilliant on a colour monitor.

(iii) The characters on the screen may be fuzzy, paticularly if a computer puts 80 characters in a line.

Several computers have built-in modulators that work well if they are used with modern solid state TVs.

Display Technologies

Computers use many types of display devices. The important ones are:

1. Cathode Ray Tubes.
2. Liquid Crystal.
3. Electro-Luminescent.
4. Gas discharge.
5. Electrophoretic.

We shall discuss the first one in detail which is the most important & widely used technique. Briefly we shall also touch upon liquid crystal display

Cathode Ray Tube (CRT)

The CRT monitor is the most important display device. The basic principle of a CRT display is that an electron gun rapidly fires & bounces off a video screen coated with phosphor material The hitting of electrons makes the phosphor to glow which we see as an image on the screen The more powerful the hitting, the more the light produced.

An electron gun emits the high velocity beam of electrons & scans the screen over & over, firing electrons at very small intervals. The energy of the beam can be varied so that the force with which it hits the screen and therefore the intensity of glow is varied. Also, the direction of the beam can be changed by applying some magnetic field so that the beam can be bent to hit on the creen at selective places.

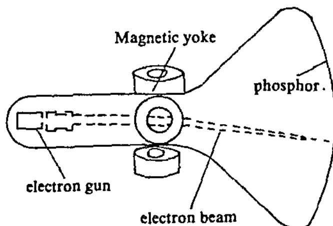


Fig 12.2 The basic CRT

The light emitted from phosphor fades away rapidly after its appearance. To maintain a steady picture, the beam is made to hit many times over all the points to be lighted, normally 30 times in a second The process is called 'refreshing'.

The CRT terminal is a very rugged device. It requires almost no maintenance. It doesn't demand a dust free environment or very clean electrical power. One has to only position the CRT for best comfort & view.

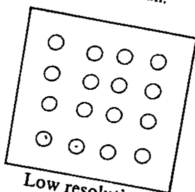
Normal CRT generates a single colour display: green or amber or white or some other. A colour display is obtained by using many layers of phosphor materials of different colours on the screen. Since the three primary colours red, green and blue can create all colours, one layer of each colour phosphor, red, green & blue is deposited on the screen.

The basic principle of colour generation is shown in fig. 12.2

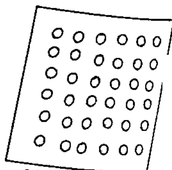
Pixels and Matrix: In both monochrome & colour CRTs images are formed on screen by very small dots called pixels (picture elements). Each pixel is a dot on the screen. The larger the number of pixels, the sharper & clearer the picture.

Characters are formed by a character generator chip in the computer which determines the number & arrangement of the pixels A particular character is formed by using a matrix of these dots lighted at specific points & not lighted at others. Characters are uniform in size & easily recognizable, the clarity depending upon how closely the dots are to each others.

On non-graphic monitors, the resolution is in the range of 320 x 200 (low resolution) to 640x400 (moderate resolution). For good graphic displays, a resolution of 800 x 400 (high resolution) or still higher is needed for special applications such as CAD (computer Aided Design). In short, graphic displays are costly & unless th application really demands them, one should not go for graphic display just for fun.

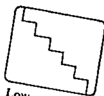


Low resolution

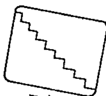


high resolution

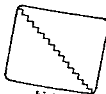
Fig 12.3 RESOLUTION OF A DOT PATTERN



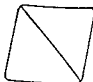
Low resolution



medium



high



very high

At poor resolution the diagonal lines have a staircase appearance
Fig 12 4 Plotter or display quality VS resolution

Refreshing: In a video, a pixel glows only for a fraction of a second & then fades. The time for which it glows is called the fading time. It depends on two factos:

(i) the chemical composition of the phosphor coating on the screen &

(ii) Voltage of the electron beam.

A scanning mechanism is provided inside the tube that keeps refreshing the pixel, between thirty to sixty seconds a time The constant refreshing makes the image apparently remain ...ed. If refreshing is done at slower rates, the image would flickering.

Composite & RGB Monitors

Two events happen simultaneously during the refreshing process:

(i) Synchronization — The electron gun has to be precisely told by the computer as to which pixel on the screen has to be hit by the beam

(ii) Video — The information about the state ON or OFF should be determined for each pixel. The computer tells the gun whether or not to fire a pixel as it comes into view

Synchronization and video signals can be coordinated in two ways and monitors are classified according to how they do it

1. Composite Monitor: It receives synchronization and video signals both as one signal i.e. a composite input.

The common example of a composite monitor is a black-&-white or colour home TV. In a TV, the composite video & synchronization information is sent through the air as a signal, the TV antenna picks it up, converting it into picture and sound

It is possible to connect most of the home computers to a TV. When a TV is used as a monitor, something has to 'broadcast' a composite signal to the TV. That something is called an RF (radio frequency) modulator or a video modulator which is a tiny low power transmitter. It sends signals from the computer to the TV. It is similar to that built into video games. The output from the modulator becomes the input to the antenna connectors of the TV.

Composite monitors can be both monochrome & colour. The colours are produced by mixing the three primary colours red, green & blue.

2. Direct Drive Monitor: Also called an RGB monitor, it receives synchronization & video signals on seperate channels which are controlled by the computer. A clock in the computer is used to time the sweeps of the electron beam. Processing circuitry keeps track of where the electron beam is aimed at all times Video signals are sent out at the proper moment, causing the gun to fire or remain silent when the target is in sight.

Direct drive monitors, like composite monitors, can be monochrome or colour. The colours are produced by mixing the three primaries red, green & blue. The signals are sent to each of the three colours on separate lines to produce the coloured image.

An alternative technology permits sending of composite signal o only one line

Composite vs Direct Drive

The direct-drive colour monitors are called RGB monitors, the initials stand for red, green & blue, the three primary colours. Composite monitors also produce colours by mixing the same three primaries & they should also be called RGB monitors. However, by convention. 'RGB monitors' are understood as 'direct-drive'colour monitors only.

The amount of colour information a computer can handle (called the colour bandwidth) decides the colour quality of a monitor As far as quality of colours displayed is concerned, there is no basic difference between composite & RGB monitors. Both can produce a spectrum of up to4000 different colours. Different brands & models however,vary in colour quality.

Each, composite & RGB monitor, has advantages & disadvantages which one has to weigh before buying one. Composite monitors are the cheapest colour monitors but have lower resolution than RGBs.

IBM-PC & some other computers use a RGB colour monitor. They produce best quality colour displays. They have separate input for, the brightness of each element in the display (luminance) &, the colour (chrominance)

Colour Monitors

Computers that have colour display capabilities, need colour monitors or colour TVs to display colours. The least expensive colour computers have attachment for connection to a colour TV. Some provide connection for both a colour TV & a colour monitor. IBM-PC provides connections for both a TV & a monitor.

Generally a micro offers colour option, from a 'platter' of colours. Most micros allow choosing of 8 colours from a pallet of 16. Some other may give option of up to16 from a pallett of 64.

When it comes to colours, monitors can be distinguished in two ways. They come in different screen colours & for a given screen colour, they may display a number of colours at one time. At least three different screen-colour monitors are available in the t.

Display Colours	Screen Colours
1. Monochrome	1. Black & white
2. Colour	2 Green

Black & white: Is least expensive. Mostly used with inexpensive computers.

Green: Slightly expensive. Data is displayed in shades of green. The green colour is very pleasing to the eye & when looked at for long times, doesn't cause much eye-fatigue

Amber: Slightly more expensive than green ones Data is displayed in shades of Amber. They cause least eye fatigue & are therefore preferred in most business micros.

Amber VS Green: The glow that is caused on an amber screen, due to the type of phosphor used on amber screens, grows bigger slowly and fades away slowly. The brightness of the glow constantly varies & stays for a long time. This produces a flickering screen display. You may be unable to see the flicker but such a screen causes eye fatigue because the viewer's eyes are always trying to adjust to a constantly varying brightness.

The longer glow is a disadvantage for video games since fast moving shapes on the screen will leave trails behind. However, for business and professional work where much movement is not needed for long times, the amber screen is alright.

So, amber screens are normally preferred on monochrome monitors used for business and professional applications & green for general purpose applications.

Graphics Display:

The video display is used for displaying characters involving alphabets, numbers, punctuations & some special symbols. Sometimes, however, graphs, charts, drawings, picture etc. are desired to be displayed. These are popular & important tools to represent data & they make comparisons, trends & patterns easier to understand.

These two different requirements are met by generating images on the screen in one of the two ways:

1. by character mode.
2. by bit-mapped mode

Irrespective of which mode is used, most computer systems have a character generator ROM (except very fast computers that

operate in a pure graphics mode). This character generating ROM chip contains predesigned patterns for alphabets, numbers, common symbols & some not-so-common symbols. (We shall use the term symbol to represent any one of these symbols). The pixel information for each symbol is stored in the memory. In both modes, the computers use their respective ROM-chips to produce the symbols.

Character Mode

In a character mode the pattern of a character or a symbol is read from the ROM & the computer sends image information en-block i.e. the pattern is created en-bloc on the screen. The display is made by using a set of stencils to write symbols. Only certain shapes can be produced & they have to fall within the prefixed size boxes.

Bit-Mapped Mode

In a bit-mapped mode, a pattern is read from the ROM & then it is created bit-by-bit on the screen. In this mode, individual pixels can be turned on or off. By manipulating various permutations & combinations of pixels, innumerable shapaes can be constructed & displayed. The technology is versatile and extremely useful for graphic since, it can produce images that are not available in the ROM-chip.

Character VS Bit Mapped Mode

Most character mode systems store a few graphics type characters like little boxes, corners and other building blocks Limited graphics & images can be built up from them. The images look like Braque paintings. In comparison,the designs generated by a graphics systems (i e. bit-mapped) can be quite sophisticated. However, to take full advantages of a graphics system & to create best designs, the screen must have a sufficiently high resolution and good software

In a computer using character-mode, the display is faster & characters are more legible. Also it requires less of memory (RAM) for storing the total contents of the screen. On the other hand, bit-mapped displays are slow & characters generated are less legible. So, broadly speaking, a computer user primarily requiring textual display, should opt for a computer using character-mode ·.lay & a user primarily requiring graphics display should opt a computer using bit-mapped display.

Computers are available which can employ both the modes, eithe the user can select the mode, or the application program selects it automatically. Sometimes the two modes can even be interleaved which is a very avantageous situation.

Graphics and Resolution

In both monochrome & colour CRTs, images are made up of luminous spots called pixels (picture elements). The picture details & clarity of the image is determined by the number of pixels on the screen. The total number of dots on the screen area which can be illuminated is known as resolution. The higher the number of dots i.e. the higher the resolution, the better the quality of the image produced.

Low resolution graphics uses fewer pixels & gives rise to rectangularness in the characters displayed. High resolution graphics produces clearer & sharper pictures.

For high-resolution, more memory in RAM is required to store the image, the image creation is slower & the monitors are expensive. Thus, for greater clarity of picture, one has to loose on memory, time & money. Therefore, one should not go for high resolution graphics unless the application really demands it.

Printout

It is important to note that the processes of character & bit-mapping can be differentiated only for the purpose of display. When a printout is desired, say of graphics display, the quality of the printed graphics will depend on the printer (or the plotter) & the software, & not on the video. The printer-signals & video-signals are created independently by the computer. So, while it may be easy to create graphics on a graphics display, a printout of the same may be difficult to obtain.

INTERACTIVE COMPUTER GRAPHICS

It is a two way communication between the computer and the . The famous example is video games. The pictures are generated, moved about and manipulated by the user with the help of an input device like a key, or switch, or handle, or paddler, or lever. The effect is immediately seen on a video screen. It is unlike a home TV where the viewer cannot control the picture appearing on the TV. A picture on a TV is an example of 'passive' graphics in contrast to 'interactive' graphics on a game video.

In interactive graphics, the user gives commands by input devices and the computer after receiving the instruction signals, modifies the picture immediately according to the instructions Thus, the user can 'converse' with the computer.

The picture on the video display is formed by hundreds of dots called pixels. To display characters, a pattern or matrix of pixels is used which is different for each character.

The precision or sharpness of a display is decided by resolution. This is the number of distinctly visible dots that are displayed in a given area of the screen. A typical resolution is 100 dots per inch (dpi) which means that if two dots are 1/100" apart, they can still be seen as separate from each other. If the distance is reduced, they would appear continuous. So, for continuity in a display, the video should not separate adjacent dots by more than this distance

In computer videos, the quality of display is very important. Number of technologies are used to produce good quality displays. The prominent among them are Cathode Ray Tubes.

GRAPHIC DISPLAY & SOFTWARE

Graphics features can be added to a computer by purchase of suitable software at small costs. Circuit boards are available which go inside the computer. Combined with the software, sophisticated graphics can be generated by giving graphics commands to the computer.

Many companies sell graphics add-ons. Even the smallest computers which might be lacking graphics capabilities, can be upgraded by these add-ons and circuit boards.

Many computers already have required hardware but software has to be purchased seperately. Writing graphics software is very complicated, so buying readymade from the market is advisable. It helps the user who can't write his own programs in BASIC or machine languge.

The software for graphics can be divided in three categories.

(i) Predesigned: This class of software consists of pictures and designs on a disk or cassette which can be loaded to your computer and you get on the screen what is there on the disk. Not much useful since you can't develop your own graphics.

(ii) Games: The second class is the famous graphics created .. video games. Graphic-aid-programs are available for crea-

ting your own graphics. Number of computer companies sell such software. However, the colour graphics generated by this class of software is very poor though the computer hardware may be capable of generating excellent colour graphics.

(iii) Business Graphics: The last is the most versatile class. You can create all kinds of graphs, bar, pie, gnatt & so on. Headings, footings, labels and data etc. can all be put together and various sizes of graphics is possible.

COLOUR AND GRAPHICS

Two features, colour and graphics are very important with video display. With these capabilities, you can produce charts of many kinds, like bar, pie, line, etc. One can play video games. All sorts of designs and figures can be created. The features are important for all recreational, educational, business & general purposes. It makes games and learning more interesting.

Generally graphics and colours go hand-in-hand which are good for graphics application. For text display, colour is not as good as a monochrome.

The key to graphics capabilities is the software and the hardware both. You need hardware which caters for graphics and software which has graphics programs.

The application packages which are best from graphics point of view are the ones which integrate wordprocessing with spreadsheet and database. The best ones are Lotus 1-2-3, Symphony, Ashton Tate Framework, Psion Xchange etc. They permit automatic creation of various types of charts and graphs from the data entered by the user in database. The packages work interactively in the sense that when the user changes the data, the charts and graphs adjust and reappear automatically.

COLOUR OR MONOCHROME

One of the questions which a micro buyer has to answer is whether he should go for a colour or a monochrome monitor. It should be decided by applications.

Graphics in Colour

In graphics applications, apart from text; charts, graphs & other visual illustrations are produced which are more pleasing to eye if they are in colour. Also studies of comparisons & distinctio

of items displayed can be made better with different colours. Therefore, graphics applications often use colour monitors

Text in Colour

One can certainly use a colour screen from non-graphics work It may be a great fun to work with lots of colours on the screen even if we take the printout in black & white. However, colour for text is an unnecessary expense.

The colour has other disadvantages too. It results in less clear image, than a monochrome, which causes eye-fatigue Colour screens are quite expensive. Also, you will have to buy colour-cards to use in your micro.

Disadvantages in Colour

Colour monitors, in general, are of limited use due to two distinct disadvantages·

(i) Occupy Large RAM

Colour monitors use a great amount of RAM. Whichever kind of display is used, the information on the screen has to be kept in RAM at all times.

Average quality monochrome monitors need space in ROM for only one video signal, ON or OFF The high quality monochrome monitors provide selection of low/high intensity as well Thus, we need to store at best two video signals (ON/OFF & low/high intensity) in superior quality monitors. If eight bits are used for storing one signal, a maximum of sixteen bits are used up in ROM

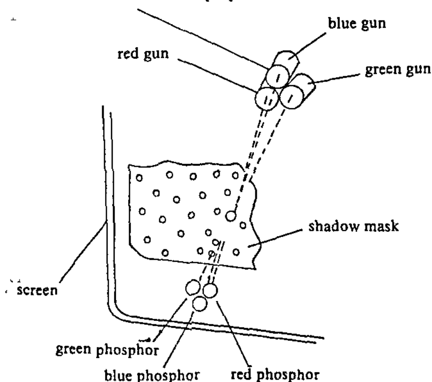
Colour monitors requre to store ON/OFF signal for each of the colour generated from three primary colours. By mixing the three primaries, a colour monitor can drive eight colours (2 × 2 × 2 i.e. 8 possible combinations of three basic colours red, green and blue; black & white are included in these 8 combinations since white is actually red + blue + green, and black is no-red + no-blue+ no-green) More versatile colour monitors provide low/high intensity selection also. Thus, we need to store 16 signals (ON/OFF and low/high intensity for each of the eight colours) in superior quality colour monitors. So 8 × 16 or 128 bits are used up in ROM for each of the character or dot (as the case is) on the screen. This is a much higher drain on the ROM resources than in case of mono- . . monitors

(ii) Eye Fatigue

Colour monitors cause eye strain even when they are used in black and white mode. How severely one individual will suffer is a subjective matter and will depend on the individual concerned. To explain why it happens, we would have to understand how colours are displayed on a monitor.

A colour is generated by lighting and overlapping of dots of three primary colours red, green and blue. White is made up of full intensity dots of all three primaries and black is absence of dots of all three primaries. If the dots making a colour are lined up properly, everything is fine. But all the spots on an average quality screen are not perfectly aligned at once. That is, when one area is in focus, other areas may not be. The reading of full text on the screen would mean reading of some letters whose dots are completely lined up and some letters whose dots are not. Reading this type of information requires visual effort and is quite tiring for the eye.

It is therefore advisable that to save money, unless really needed, a colour monitor should not be used. One should opt for monochrome if it can serve the purpose.



SELECTION OF A MONITOR

Before buying an external monitor a careful evaluation of the following has to be made. Many application programs only run on monitors which have a minimal of these parameters.

Screen Size: How big it is. Height/Width/No of columns, and rows of characters it can display at one time.

Most popular screen size is 24 lines × 80 characters i.e. 1920 locations minimum. This screen measures 10" x 8".

Reslution: The maximum number of dots (pixels) a CRT can display at one time is a measure of its resolution. Resolution is usually stated as a product of vertical by horizontal dot locations. A screen with a display of 300 x 200 pixels means that the screen has been divided into 300 rows and 200 columns. The intersection point of a column and a row is known as a pixel or dot and the computer is capable of controlling all such dots, in all 300 × 200 i.e. 60,000 dots.

The larger the number of such dots, the finer and clearer the display. A normal display of twenty-four lines by eighty characters should have a resolution of 200 x 300 pixels.

Counting pixels is extremely difficult. An alternative to counting is to examine a full screen of single-spaced text. The descenders on letters like "p" and "g" should go beneath the line & ascenders like 'd' & 'f' should go above the line & separate lines of text should never touch.

Focus: Every character on the screen should be sharply defined and well contrasted with its background. Also the focus should remain consistently good in all parts of the screen. Low-quality CRTs produce sharp characters in the centre of the screen but blurred ones around the edges & corners.

Controls: Most CRTs have number of options via knobs & switches. They should be placed properly for operator convenience & efficiency. They are important & should be easily accessible to the user. Most videos have seperate 'brightness' and 'contrast' knobs. For user convenience they should be placed on the front. Like television, videos should also have vertical and horizontal image adjustment control knobs.

Glare: Primarily a local phenomenon. Depends on environment conditions & can be reduced by repositioning or by use anti-glare shield.

Colour: Most of the micros come with built-in monochrome displays. In a monochrome screen, the information is displayed in one colour against a different colour background. Green on a dark background is most common, though various permutations of black, white and amber are also common. Green on abmer are regarded as easier on the eyes. If you don't like your screen colour then you can usually fix a tint over it & have, more or less, the colour you want.

Brightness; The most important factor for user comfort is screen brightness. CRTs have knobs by which brightness on the screen can be controlled. One should use the lowest level of brightness that is comfortable to his eye.

Reverse Video: Generally on a video, the screen is dark & the characters appear as closely packed bright spots on the screen. However, some videos permit 'reverse video' in which you can reverse the colour of screen & characters. Characters are shown in dark against a bright background e.g. black characters against white background.

Dot Density & Character Legibility: Resolution is only a quantitive measurement. There are other qualitative differences which are extremely important. Two such factors are:

(i) Dot density & active display area
(ii) Character legibility.

The dot density means the density at which pixels are packed together. This, & the overall display area largely determine the clarity of charts or graphics. This has nothing to do with physical size of the screen but the size of the area which is displayed actively. The borders of a monitor may not be as well lighted as the central portion. The resolution & active area should have a good balance.

The characters on display are formed into matrices of size say 7 × 9 dots. The symbols should be large so that they are legible from a distance. This again has nothing to do with resolution. Many applications require 24 lines of text with 80 characters in each line. Sometimes a sixty-column monitor may fit in 80 columns & the matrices generated are not legible. Such monitors should be avoided. Also, the quality of images generated should be examined with your applications rather than with demonstration packages.

Optional Screen Features: They include

* Full screen edition (ability to move the cursor anywhere on the screen rather than just on the current line)
* The use of lower as well as upper case letter (which is useful for wordprocessing)
* Flashing (alternative between normal and reverse display)
* Audio signals (such as for signalling input errors)
* Animation (primarily for games and education)
* Scrolling
* Music. etc.

Display Speed

A CRT terminal normally operates in the range of 110 baud to 19200 baud A baud is equivalent to a bit per second (bps) The higher this rate, the higher the data transfer speed between the terminal & the computer.

A micro is normally provided with a switch for selecting number of baud rates. However, the highest speed is decided by the communication software or the communication interface used, rather than by the computer Whichever is the case, you should use the highest baud that the computer can support. No doubt, a CRT would operate without trouble at lower speeds also, but you are unnecessarily wasting the time in waiting for the ouput to be displayed.

Most CRTs are provided with a female Rs-232 connector which can be connected to a printer with a male Rs-232 connector. Once a printer is connected, whatever is displayed on the screen, can be printed simultaneously on the printer.

Printers work at slower speeds than CRTs For instance, a printer may operate between 300 to 2400 baud compared to 9600 or 19200 baud for CRT. Hence, when a printer is connected to a CRT, the baud rate of CRT should be reduced

Some CRTs have 'buffer-memory' which permits connection between a 'slow' printer & a 'fast' CRT.

Compatibility

Hardware & software compatibility are important & have to be examined before buying a display type. Some computers can accept only one type of monitor & not the other. Some can accept ther. Some may drive an RF modulator, others may not The

expansion slots & the ports in the computer determine which monitor types can be used.

The operating system of computer is generally capable of displaying simple outputs. However, complicated outputs are directly controlled by the application program which generates display outputs. This is particularly true when colour is used. Some application program may require composite monitor, other may require direct drive & some may require either. Thus, the choice of a monitor-type is decided by the application software. It is therefore advised that a monitor should be bought after the application software has been decided.

Display capability is a good test for testing IBM-compatibility. Some micros which cannot mimic PC would not be able to properly display many of the application programs specially written for IBM-PC.

Upgradation

In a computer, the standard display circuit may have some limitation. For instance, in Apple II computer, the output is 24 lines x 40 characters which is quite unsuitable for good word-processing. Sometimes one may not like the video display system supplied with a business micro which may have excellent text displays and crude graphics but may lack sophisticated graphics features. Often, the video can be modified so that it can also display excellent graphics.

Several companies offer expanded display circuit boards & interface cards that can be plugged into the computer & enhance its display capabilities. One can buy a board for Apple to make it to have 24 lines x 80 characters (upper/lowercase) display. Interface cards can be bought which add graphics features to the micro lacking it. Devices are available that can take colour photos or slides of colour graphics of figures on the video screen. These systems, though expensive, allow to design, create & display colour charts, figures etc. A hardcopy of these displays can also be obtained from special printers. Such displays are very useful for reports & presentations.

The IBM—PC has two display systems. One monochrome [illegible] one colour. The monochrome display card generates [illegible] character text output on a video. The colour display card [illegible] very high quality colour/graphics. If the user wants [illegible]

text display & colour graphics he can buy both IBM monochrom & IBM colour display cards. Alternatively one can buy a sing card having both features, from a different manufacturer.

Liquid Crystal Display

Liquid crystal displays are well known. They are found on calculators, digital watches, electronic typewriters & number of other products. Many protable microcomputers also use LCDs

The LCD technology uses organic compounds that show son of the physical properties of crystals but flow like liquids. It is passive technology in the sense that it emits no lights of its own. Some mirrors do the whole thing. Contrast can be partly varied through a knob provided on the display. The legibility depends on surrounding lighting conditions & viewing angle.

The advantages of LCD are that they occupy lesser space, consume extremely low power, can work on battery, generate very less heat. They are therefore very useful for portable micros.

The disadvantages of LCDs are that they have poor contrast, high cost, slow speeds, low resolution & very narrow viewing angles. Research & development efforts however, are likely to overcome some of these shortcomings in near future.

Digitizer

A digitizer or a graphics tablet is an input device fc generating graphics. It is used to generate graphs, tables, figures etc., on the Video screen of the computer,

It's generally 2 feet square flat pad. A 'stylus', also known as a 'sensor', is moved over the surface of the tablet and as it is moved, a line is drawn on the screen.

To produce a map one can put the map on the tablet and trace the outline of the map with the stylus. The map would be produced on the video screen. With the help of a graphics printer, the video display can be taken as a printout.

Alternatively, the figure can be saved on a floppy or hard disk and used later in a program.

Many tablets use a pantograph approach rather than a stylus mentioned above The pantograph is a hinged drawing arm which ~n be moved on the tablet surface and as the arm is moved it

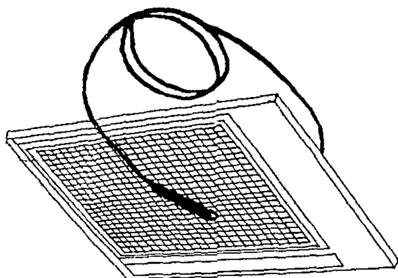


Fig. 12.6 Graphic tablet

sends data corresponding to the position of the tip of the arm and a pattern is produced on the video screen.

Mouse: A mouse is an input device that can be moved around a flat surface by the user. It's connected by a cable to computer and is used to send instructions to the computer They generally move on wheels or ball bearings. There are some others which can be mounted on special sensor grids. The movement of mouse is sensed by the computer & translated into cursor movement. The mouse has switches on its back to send commands to the computer.

A mouse facilitates the following basic functions of a computer:

(i) Cursor Control
(ii) Editing of text & data
(iii) Permit selection of a commond from the menu.
(iv) Produce graphics.

The idea behind the use of a mouse is to reduce the use of computer keyboard. It has a number of advantages. The complicated key sequences for instructions are eliminated. Also some operations, like moving a cursor diagonally, can be achieved very quickly by a mouse than by the cursor keys on the keyboard.

Out of the possible tasks displayed on the screen, the cursor is taken to a desired task which is selected by pressing a switch on the mouse & the task is performed.

Unfortunately, the mice have not been as popular as anticipated since their discovery. The mouse was invented about three decades back & yet it's not a standard item on all micro-computers. The user is advised to try it out & discover the pleasant change over the customary keyboards.

Joy Sticks: Joy stick is an input device which is used to move the curosr around on the computer's screen. The stick is generally held in the hand by the user and is mainly used for playing games on computers. Some models are designed to stand on a table.

It's used to draw interactively on the screen. Designers and artists can produce extremely sophisticated & complicated designs by using this simple-to-use device as a graphics input device. The all he needs is appropriate software. The resulting picture can be stored on a floppy disk for future use and a hard print can also b- drawn out on a plotter, often in colour.

Some joysticks, designed specially for the purpose, may even allow shrinking or enlarging of the drawings, rotate them, position them wherever one likes them on the display screen. Thus, a very complex design can be created, a piece at a time, with each piece being shrunk once it's finished, and positioned properly in relation to the other parts of the design. One can 'Zoom in' on any part of the image, the amount of details limited by the disk space available on the computer at the time of 'Zooming'.

Light Pen: A light pen is another input device for sending instructions to a computer. It is shaped like a normal pen & is connected to the computer by a cabel. The pen is held in hand by the user, the 'writing-tip' touching the screen. The tip can be moved around the screen & when a switch provided on the pen is pressed, the computer senses its position. Lines between the selected points can be filled in by the software or one can select the options from the menu listed on the screen.

Light pen is cheaper than mouse but its disadvantage is that after long use, it causes arm-fatigue due to vertical movements needed on the screen. It is unlike the mouse or the digitizer requiring horizontal movements which are more natural & less tiring.

13.
Printers

PRINTER

A printer is a device that can record information permanently. The printout is called a hardcopy. A printer is necessary for business applications like wordprocessing, where a hardcopy is a must for easy reading & record.

The CRT can't provide a hardcopy of the information displayed by it, only the printer can do this job.

A printer is a device used with the computer which has the largest number of mechanical & moving parts. It's very sensitive to rough & improper handling.It is most unreliable & most likely to fail compared to other devices. The printer should therefore, be operated intermittently so that the probability of failure is minimised.

CLASSIFICATION OF PRINTERS

Like the classification of computers, the printers used for microcomputers are classified in a number of ways:

1. Impact& non-impact—The most important calssisication is based on the principle whether the characters are printed by striking the paper (& produce noise), or by prinkling or developing the characters through non-strike process (& do it silently).
2. Character-by-character or line-by-line printing—The next classification can be made based on the principle whether the characters are printed one-by-one or more than one character (often a full line of characters) is printed simultaneously. Some printers like laser printers can even print a full page at a time.
3. Dot Matrix VS fully formed characters—Yet another classification is based on the fact whether the characters printed are fully formed (Like the ones typed by an ordinary office typerwriter) or they are made up of tiny dots, each character having a particular pattern of dots to give it an appearance of that character.

TABLE 13.1

Computer Printers
(CPS-Characters Per Second; LPM-Lines Per Minute: LPS-Lines Per Second)

Character	Impact Non-Impact	Capacity	Printing Technology	Approximate Speed	Model example	Advantages	Disadvantages	Use
Fully formed	Impact	Character by character	Ordinary bar typewriter	5-10 cps				
			Cylinder	10 cps	3 Tele type			
			Ball	15 cps	IBM electric			
			Daisy-wheel	30-55 cps	Diablo	fully formed, excellent text, multiple copies	slow, limited graphics	correspondence word-processing
			Thimble	30-55 cap	Spin writer			
		Line	Band	upto 3000 lpm		Interchangeable character set		
			Chain	Upto 2000 lpm		Interchangeable character set		

			Train	upto 2000 lpm		Interchangeable character set		
			Drum	300-2000 lpm			slight vertical misalignment at high speed	
	Non impact	Line	Laser or Xero-graphic	4000-2000 lpm		high speed, high volume printing	high cost	
			Photo optical	150-1000 lpm		Good for type-setting with mini-computer controllers		
Dot matrix	Impact	character by character	Wire print head	30-330 lpm	Centronics Data	high speed, graphics possible		general purpose
		Line	Print comb	upto 600 lps				
	Non impact	Character by character	1. Thermal	30-120 cps	Alphacom	Low cost, low noise	requires special paper, no multiple copies	
			2. Ink jet	30-1000 cps	Diablo C-150	fast speed, excellent colours	special paper, high cost, no multiple copies	Engineering, trial output
			3. Electro-static	160-2000 cps			special paper, low print quality	

Line	Electro-static Electro sensitive	Thermal 300-18000 lps	Diablo EPM-1 Axiom	Special paper & toner process

Based on a table from "MC Graw Hill Computer Handbook" 1983

Table shows the complete ASCII code set, which includes a full set of upper and lower-case letters, A to Z, the numerals 0 to 9, a range of special symbols used in text representation plus a set of international codes.

Each character is made up of 7 bits, but can be represented as a binary or hexadecimal number. The vaule for any character is determined as a combination of the numbers appearing at the left hand side of the row & the top of the column in which the character appears, e g the letter 'A' is represented as hexadecial 41 or the binary representation 1000001.

Classification of Printers

1. **Impact**	**Non-Impact**
(a) **Principle of Printing**	
Character is formed by striking against a ribbon which leaves an impression on the paper.	Character formation takes place without any direct striking on the paper
(b) **Examples:** Daisy wheel, Dot Matrix, Line	Thermal Ink Jet Laser
2. **Formed characters**	**Dot matrix characters**
(a) **Principle of Printing:**	
The character being printed is hammered against the ribbon as in ordinary typewriters.	The character is formed on the paper with a precisely coordinated set of dots
(b) **Print elements:**	
The characters are created with typing elements of three common configuration:	(b) The dots may be formed with:
(i) The ball element (Selectric) (ii) Daisy wheel (Diablo) (iii) The thimble (spinwriter)	(i) hammered wire (dot matrix) (ii) heated wires (thermal) (iii) ink-droplets (ink jet) (iv) laser beams (laser)
(c) **Comparison**	
Good for formal correspondence & reports. Slow speed, Limited graphics printing, Simple enhancements like boldface available	Some dot matrix printers can can produce full colour images. By now have evolved into highly sophisticated printing machine, the character appearance as near to fully formed character printers as possible. Since the dot matrix printer page can be addressed dot by dot like a video display screen, this type of screen can reproduce any image that the screen can display

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Various types of printers are manufactured and are available for microcomputers. New techniques are constantly being developed. Many of them are designed for specific applications, some may suit certain applications better than others. Understanding the variety of features will help in selecting the right printer for your applications.

Impact Printers

Impact printers print characters by striking the type against a ribbon and the paper which leaves an impression on the paper, just like an ordinary typewriter does. Because of impact prócess they,like ordinary typewriters, can also produce ıcarbon copies of documents.

On an impacat printer, the type element may be bydirectional, which means it moves first from left to right and then from right to left, unlike a normal typewriter.

Impact printers that print one character at a time are called character printers. These printers, which may or may not be bidrectional, are used for letters and other kinds of output that must be of high quality. The type element on a character printer includes upper and lower case letters. Type elements are available in pica, elite and micro size (15 character to an inch) as well as in many typefaces. One can change them as one changes the typing elements on any elementary typewriter.

Dot-Matrix Printers

The ordinary and conventional office typewriters cannot handle the speed and performance required by microcomputer users. The dot-matrix printers, the products of digital technology, can print very fast, at speeds of 100-200 characters per second (CPS). They can continuously print hundreds of pages. Also,their prices are coming down gradually and can be afforded by most personal computer users.

The term dot-matrix refers to the way in which a computer device like video monitor generates characters from digital data, the bits. If one looks closely at the video monitor of a computer, one will see that both text and graphics are made up of tiny dots. A dot matrix printer also produces characters which are made up of closely spaced dots. A letter or shape is formed as a pattern of tiny ink dots on the paper. The sharpness and size of a character is decided by the size of what is known as a 'matrix'.

A dot matrix printer has a fixed matrix size into which each character has to fit in, independent of whether the is a letter, a number, a mathematical sign, a

punctuation mark or any special symbol which the printer can print. The information about each character comes from the printer's memory which decides each character's dot-pattern within the matrix.

A matrix size '7 × 9' means that a character would be formed in a matrix of 7-dots wide & 9-dots long. The matrix sizes vary from printer to printer, anywhere from 3 × 5 to 9 × 14. Some examples of typical matrix sizes are 5 × 7, 7 × 7, 8 × 8, 7 × 9, 9 × 9, 9 × 12, 9 × 14 etc. Figure shows characters formed by a 7 × 7 matrix.

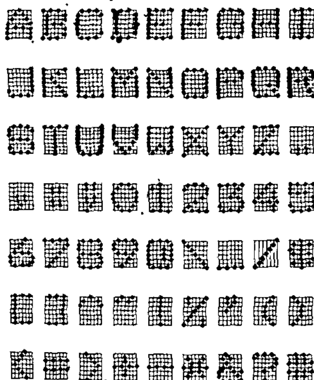


Fig 13.2 Character set of 7 x 7 dot matrix characters

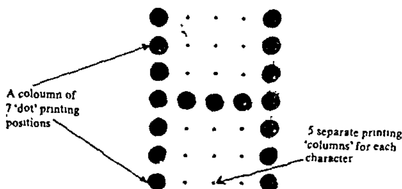


Fig 13.3 Dot matrix character (7 x 5)

For applications where capital letters only are enough, a 5 × 7 matrix is used. This size however, cannot handle lowercase letters since it does't permit enough space for 'descenders' & 'ascenders' in consecutive-line. For both lowercase & uppercase requirements, a 7 × 9 matrix is good enough.

There are two methods for printing a dot matrix character;

(i) Impact &
(ii) Non-impact

Impact Dot-Matrix Printer

The impact-method makes use of what is known as a 'print-head' It is the print element of the dot matrix printer and is the main secret behind the quality of the printer. Printer head is a column of closely spaced, magnetically actuated, tiny hammers (or wires or pins) For a 7 × 9 matrix, the print head would have 9 pins Some printers may have other arrangements For instance, printers are available which have two or three columns of wires rather than one so that their print speed is comparatively higher.

The print-head slides back & forth horizontally along the paper It receives instruction from the computer and specific pins are selected which hammer (or strike or impact) against the ink ribbon to print a vertical column of dots on paper. The print-head shifts horizontally and hammers a different set (or may be same set, depending upon the character) of pins. Specific characters are printed onto the paper through the process.

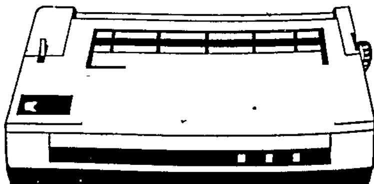


Fig. 13.4 Dot matrix printer

For a printer using a 7 × 9 matrix system, the complete character would be formed within a 7 × 9 matrix after 7 such consecutive firings.

Earlier printers could print only capital letters but present models print both lower & uppercase letters. Also, most dot matrix printers can print in two directions.

Dot matrix printers have one disadvantage. The print quality is not very good, not as good as that of conventional typewriters. Hence, they are normally used in applications not requiring high quality print (a high quality print is also called correspondence or letter quality print or LQP). However, now with slightly higher price, dot-matrix-printers are available which offer better quality prints (called near letter quality print, NLQP), with print speeds much higher than that of expensive daisy-wheel printers The NLQP dot matrix printers are gradually now being used even in applications like wordprocessing.

Printing Mechanism in Dot Matrix Printer

Let us discuss the mechanism of how the software in a dot matrix printer controls the print-head to fire different pins to create characters. It is interesting to note that a dot-matrix printer does not print a full character at a time but only a part of it, i.e., only one column of a dot-matrix character.

The main job of the print-head is to print characters. The process of printing a character is started the moment the computer sends an instruction in the form of an ASCII code for that character. The firing pattern for each character is available in the printer's permanent memory. As the ASCII code arrives, corresponding pattern causes the firing of pins.

For instance, let us see how the capital letter 'L' is printer It is one of the simplest alphabet character. It consists of two parts, one horizontal part, that is the tail, the other is the vertical portion. Let's presume that the printer uses a 9 × 9 matrix. The letter 'L' would be printed by top seven pins since the remaining lower two pins are used to print the tails of lower case letters like 'g', 'y', underlining, graphics characters, etc.

As the printer receives the ASCII code 76 corresponding to 'L', the print-head fires all the seven pins simultaneously in the first column, then the last (seventh) pin in the second cloumn, the last pin in third column, the last pin in the fourth column and finally,

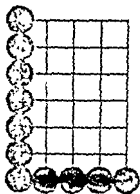


Fig. 13.5

the last pin in the fifth column The firing in the first column completes the vertical part and the firings in later columns complete the horizontal part of the letter 'L'. This whole activity is programmed into the printer's memory. It's repeated whenever the printer receives on ASCII code of 76.

Graphics

The dot matrix printers are very popular due to their graphics capability in addition to high speed & high performance. In fact, they are more useful for graphics than for their typewriter functions The high resolution available with dot matrix printers can generate good quality graphs, charts, drawings, figures etc.

A printer may have two types of graphics:

(i) Block graphics
(ii) dot-addressable or bit-mapped graphics.

(i) Block graphics consists of symbols other than standard alphabets & numeric characters. They are built into the permanent memory of the printer. A block of symbol can be printed by sending corresponding ASCII code.

The graphics is generated by manipulations of fixed blocks The individual blocks are fixed & are limited in number. However, with regular practice & innovations, one can generate impressive designs.

(ii) Dot-addressable graphics: In this mode, each & every dot on the screen & paper can be controlled. Technically it means that location of each individual dot can be defined or addressed. The address starts by first mapping out the corresponding bits in the computer's memory. Then, every pin in the print-head is fired in equence. The computer sends codes & instructs printer to semble row after row of matrices.

The resolution depends on printer model. Measured in dots per inch (dpi) it ranges from 60 dpi (low resolution) to 240 dpi (very high resolution).

Daisy Wheel Printer

A daisy wheel printer works on the same principle as conventional office typewriter and prints by striking of fully formed characters. These characters already exist before printing and are arranged around a print-element called a daisy-wheel Which character would be printed is decided by the orientation of the print-element, which in turn is decided by the instructions from the computer.

Print Wheel and Printing:

The printer's print-wheel is shaped like a daisy & hence its name (Daisy is a flower, the print element of the printer is like a flower having flexible flower-like petals). Its petals (arms) are straight type-bars & each arm of the wheel has a character embossed at its tip, like each arm (typebar) in an ordinary typewriter has characters at its tip. The character can be an alphabet, a digit from 0 to 9, a punctuation mark, a mathematical symbol or any other symbol specific to the daisy wheel A daisy wheel generally has 96 rays, each ray having one character at its tip. They are made from metal or plastic, the metal ones have longer life.

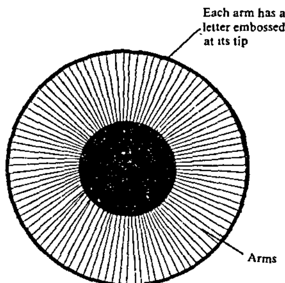


Fig 13 6 Daisywheel

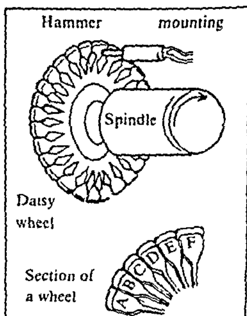


Fig. 13.7 Daisy wheel printer

The characters correspond to specific ASCII codes. When a particular code arrives from the computer, the print-wheel spins at high speed until the character corresponding to that code is upper most & aligns with the ink ribbon A tiny hammer hits this character printing it on the paper

For instance, when on ASCII code 70 arrives at the printer, the wheel rotates so that the character 'F' is uppermost, the hammer strikes it printing 'F' through the ribbon onto the paper On receiving next code, it spins to bring the corresponding character into position & so on.

Quality:

A daisy wheel printer is also known as letter quality printer (LQP) because of its excellent quality of print. They are normally used to print letters & business correspondence. Their print quality is better than that of dot matrix printers & are therefore, preferred over them in most business applications.

Speed:

The conventional typewriters are generally not used with personal computers since they can't print at high speeds desired by computer users. They are also low in performance, that is, they annot handle heavy-duty use.

On the other hand, the daisy wheel printers, the product of digital technologies, can print at speeds of 30-50 cps, faster than conventional printers. Daisy wheel printer is usually a bi-directional printer, which feature further enhances their printing speed compared to conventional typewriters. They are affordable by personal computer users.

Thimble Wheel Printers

Some printers, instead of a daisy wheel, use a print element shaped like a thimble. The mechanism, however, for both daisy wheel and thimble printers is the same.

A thimble print-element also has arms arranged in a circle & extending from a centre. The flexible petals (arms) are turned upward to shape like a thimble or a basket. (Thimble is a cap used to protect finger while using a needle.) The tip of each arm has a symbol. THimbles are generally made of plastic & the quality of their print is not as good as that of a metal daisy wheel. Like a daisy wheel, a thimble also spins regularly as it moves back & forth across the page. Its movement appears something like the movement of a 'golf ball'.

High Speed Dot-Matrix Printers

The dot matrix printers we have so far discussed use a movable print-head that strikes a single column of tiny hammers onto a paper through an inked ribbon A slight variation in the principle has given rise to a very fast & efficient dot-matrix printer.

One principle is to make use of horizontal row of hammers with a separate hammer for each character column. The striking of hammers is simultaneous but independent of each other. After printing the characters in their corresponding columns, the whole row of hammers shifts a little to the right. The whole process keeps repeating till one level of every dot-matrix in a single row is completed. Now the paper moves ahead & the process is repeated for second level of dots & so on, till one row of characters is completely printed.

The process is very fast, almost 10-15 times after than the conventional dot-matrix printing. This however, increases the cost. of the printer. Therefore, it's used in specific applications, only those requiring high speed data processing & in applications where thousands of pages are printed daily. For general personal computer applications, normal dot-matrix & daisy wheel printers are quite alright.

Electronic Typewriters as Printers: The electronic typewriters are generally designed for light use. They cannot usually withstand the heavy duty use to which computer printers are normally put. Often the typewriter printers are slow compared to even a daisy wheel computer printer (the typewriters are much slow compared to dot matrix printers). Though, some models have now come which do not suffer from this limitation.

The typewriters can be linked to a computer in similar fashion as printers are linked. Interfaces are required which are generally available with the typewriter supplier or openly in the market.

Line Printers

Advanced business applications require high speed letter quality print A daisy wheel letter quality print with a speed of 20-25 cps may be insufficient for heavy duty applications. For such needs, instead of printing character-by-character, another principle is used in which a number of character in a row are printed simultaneously

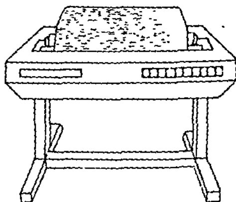


Fig. 13 8 Line printer

A number of techniques based on this principle are used. In one technique, a rotating drum having a ring of characters for each column, rotates near the surface of the paper. A number of hammers behind the paper strike the corresponding characters on the drum simultaneously. The entire line is printed in a time equal to the time taken by the drum for one full rotation.

Another technique uses moving belt of metal characters. The belt, like the drum, passes in front of the paper & number of hammers from behind the paper hit the corresponding characters on the belt.

Line printers print at very high speeds, about 5 to 20 lines per second (or about 300 to 1200 lines/minute). For 132 column printer, 600 lpm is about 1300 cps which is much higher even in comparison to a fast character-by-character dot-matrix printer with a speed of 200 cps.

They cost much higher than character-by-character printers. The quality of printing is poor for business letters. Also, even a slight misalignment in the hammers position or variation in the distance between hammers & paper can mean printing of characters at different times, some characters too early & some too late. This would cause change in character spacing giving a bad look to the whole printout. Overall, they are good for internal documents.

Ink Jet Printers

Two methods are used for printing by ink-jet printers.

(i) Drop-on-Demand Method:

In this method a character is printed in a dot matrix form, it appears like the one created with an impact dot-matrix printer. The hammers in the impact dot matrix printer are replaced by nozzles (tiny holes) in the ink-jet printer. The ink is sprayed through these nozzles onto the paper. The nozzles are arranged in a vertical column, one matrix-column high.

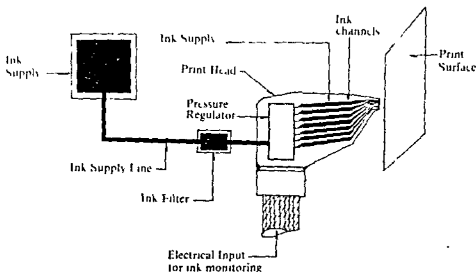


Fig 13.9 Drop-on-Demand Ink-JET Printer

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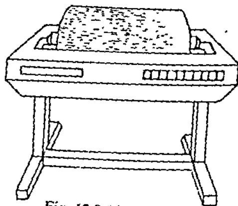


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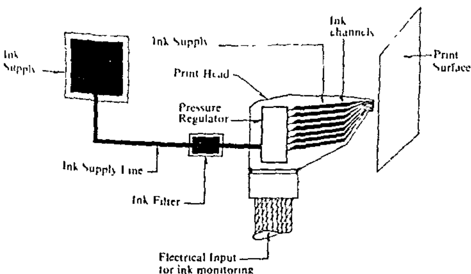


Fig 13.9 Drop-on-Demand Ink-JET Printer

Table 13.2

Comparison of Impact-Dot-Matrix, Daisy-Wheel & Non-Impact-Ink-Jet Printers

Printer Type	Speed	Text Quality	Colour	Graphics	Cost	Multiple Copies	Special paper required	Noise level	Applications
Impact Dot-matrix	Fast	Poor to fair	Fair	Fair	Low	Yes (Permanent ink)	No	Noisy	General Business
Impact Daisy-Wheel (or thimble)	Slow	Excellent	Limited	Limited	Medium	Yes (permanent Ink)	No	Noisy	Correspondence, Word-processing
Non-impact Ink-jet	Medium to Very fast	Good to excellent	Excellent	Fair to excellent	High	No	Yes (also may fade over time)	Quite	Engineering, trial output

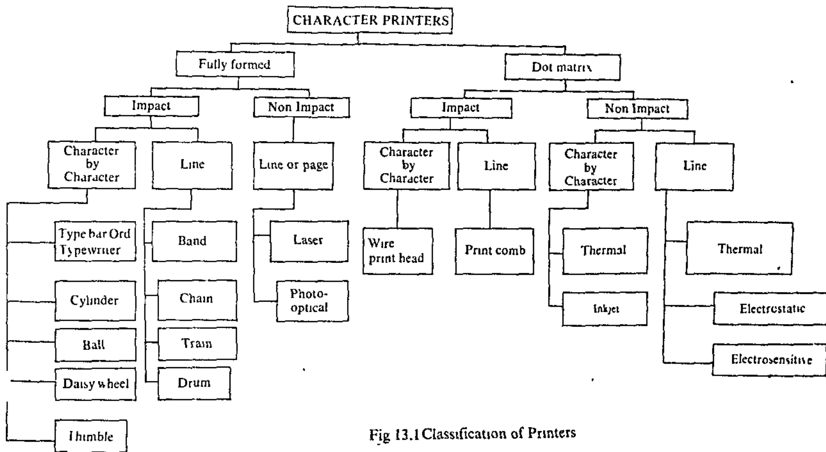


Fig 13.1 Classification of Printers

For the printing of a character, the ink is sprayed selectively in the first column of the dot matrix for the character, like the hammers are struck selectively in a dot-matrix printer. The nozzles then move in horizontal direction and eject ink for the second column & so on. A character is formed after all the columns of its matrix have been sprayed.

(ii) Continuous Ink-Jet

In this method, ink is continuously supplied through a nozzle. The ink-jet, on its path, is selectively deflected by magnetic & electric fields. It is exactly like an electron beam which is selectively deflected in a cathode ray tube to strike on the video screen. The ink jet strikes the paper , forming continuous characters. Whenever the ink is not needed (for instance for the spacing between characters), it is captured in a reservoir & used again.

The characters formed in this method are not strictly dot-matrix characters. In fact, they appear almost continuous since they are formed by extremely small ink droplets. The characters are much better than formed by 'drop-on-demand' printer.

Advantages

Ink jet printers have the following advantages:—

1. Practically noiseless. Much silent than impact dot matrix printers.
2. Produce near letter quality print.
3. Can print in multi colour. By supplying different colours of ink to different nozzles, multicoloured prints can be produced. This is specially useful for graphic displays. Some printers can actually mix the colours on paper, thereby increasing the colour possibilities.
4. Reliable—due to fewer moving parts, they are more reliable than impact printers.
5. Characters can be shaped in a variety of styles & sizes.

Disadvantages:

1. Obstruction: the ink dries very fast in the nozzles and causes obstruction in them.
2. Fuzzy print: some types of paper are too absorbent and produce fuzzy images. To avoid this, less-absorbent papers w' plastic base should be used.

3. High cost: because of their newer & complex technology, they cost more & are used only for business applications. However, recent technical developments have lowered their costs to make them affordable even for home & small business applications.

Thermal Printers

A thermal printer prints characters by 'thermal transfer'. This is a process making use of ink, heat & matrix-technique for printing on paper. The characters are printed by 'burning' them onto a special paper called thermal paper. It uses a character matrix of dots or segments like that used in dot matrix printers

Ink is transferred from an ink roll to plain paper. The ink roll passes over a grid of wires called the 'thermal print head'. It is not like a conventional print-head on a daisy wheel or a dot matrix printer Tiny electrodes, controlled by a microprocessor, selectively heat the wires within the grid causing the ink on the roll to melt A rubber roller than presses the ink roll against the paper and the melted ink in the form of characters is transferred onto the paper

In another slightly different process, as with dot matrix printers, a head passes along the surface of the paper. Tiny electrodes selectively heat the surface of a specially treated paper, causing a chemical change that turns the paper black or blue. Another similar process vaporizes the aluminium coating on the thermal paper exposing a darker layer beneath.

Thermal printers, since they don't have the conventional print-heads, are cheaper, have slow to moderate speeds, are more reliable & are less noisy than impact printers The method complicated than laser printing The printout is sharp and closely resembles an output from a photocopier

However, they require special paper which is more expensive. Even then the quality of paper appears to be worse than regular paper. The greatest disadvantage of thermal printers is that they cannot make multiple or carbon copies.

They are good for home ... nuters or ... cations where very less printin... small digital calculators use t... red. Th... appli-

They are a low cost ... ig. ... s in cost of an impact do: ... at, to

nature. Also the high quality of the hammer which has to strike thousands of times per page, & the print-head used in a dot matrix printer, put a minimal cost on such a printer.

Laser Printers

Laser technology is the latest solution to high speed & letter quality printing Instead of ink & ribbon, the technology uses focussed light The principle of laser printing is the same as that used in photocopiers.

Technically, a laser printer is a dot-matrix printer. It uses a laser, a beam of pure and red light, which can carry millions of characters at a time With high speed photography, the laser light is shaped into characters and beamed onto light sensitive paper, printing the whole page in less than a second

Advantages

1 High resolution or better print: A typical laser printer generates characters made up from 180 to 480 dots, compared to 50 to 150 dots with dot matrix printers So, even at lower dot-densities the dots are almost indistinguishable, giving the characters a 'full' appearance like with daisy wheel printers. The quality of printout is so good that a company using laser printing can use it to print Company logos & letter-heads as well It can print fascimiles of signatures which are almost impossible to distinguish from handwriting

2. High speed: They can produce quality print even up to 100 pages per minute compared to dot matrix-printers which print at about 3-4 pages per minute.

3. Type style You can produce more than one type style on a page in more than one size, right from pica to elite to micro

Disadvantages

High Cost: The prices are very high. The laser printing is cost effective for only large business houses and corporations with special printing needs

However, due to recent developments the costs are constantly decreasing Also, some inexpensive compact models are available and soon the laser printing would be within the reach of all computer users also.

The ASCII Code

A computer stores data and programs, made up of characters, as patterns of electrical impulses. For getting the data in computer printed, the pattern in the memory has to be transferred from the computer to the printer. If the printer can recognize the pattern, it translates the pattern in the form of characters and prints them onto paper

It is clear that the printer and the computer must agree on a common pattern or code for characters. If computer sends a pattern for 'T' the printer must recognize it as the pattern for 'T' and print a 'T', and not a 'B'

Characters in of the modern computers occupy an 8 bit byte, so that there can be two to the power of eight (2^8) i e 256 distinct characters. Each character is associated with a numeric character code in decimal and hex system depending on the conventions

The characters in microcomputers follow a universally accepted standard, the American Standard Code for Information Interchange (ASCII). This code is extremely popular and has been accepted by almost all computer and peripheral manufacturers all over the world. It takes care of characters (lower and uppercase both), punctuation marks, mathematical symbols and many more symbols.

ASCII character set has 128 characters in it, with decimal codes 0-127. It can be broken into two parts. The first part has first 32 characters, decimal codes 0-31, & are known as ASCII control characters. The characters from decimal code 32-127 form the second set which represents the every day characters of alphabets, numbers, punctuation marks, mathematical Symbols, etc

When a computer interacts with a printer it has to tell the printer "what to print" & "how to print it". The ordinary ASCII characters from decimal code 32-128 are what-to-print part of the `SCII set.



The primary and most important feature of ASCII code is that apart from alphanumeric characters (32-127), it covers a number of controls for the printer. These characters are very different from what they appear. They have very special use having no connection with their appearance. The 0-31 decimal codes are the 'how-to-print' part of ASCII set. These 32 codes are used to give commands or special information to the printer, or even to another computer through a telephone line and so on.

The computer has to, for example, tell the printer, from where to start, where the line ends, when to proceed to new page, when to start a new paragraph & so on. The printer should be able to advance the paper at the end of a line, set left and right margins, set tabulations and paragraphs, skip a page if required by the user, and so on Such commands are covered in the ASCII characters. Let us study table 13.4.

The second & third columns represent decimal and hex codes The fourth column is of our interest which against each entry shows a carat followed by a character. This actually means that if we press the control key provided on the keyboard alongwith a character in the fourth column, a command is keyed-in on the key board Thus, by^0 we don't mean the carat character (^) followed by character 0. What we mean is control-0 which is keyed-in on the keyboard by holding down both the 'control key' and the '0' key simultaneously.

The last but one column has the full description of the codes and last but two column has a two or three-letter code, which is a standard abbreviation for the full description of control The abbreviated codes are often used in computer literature.

These 32 control codes are used in formatting of printed material. They function in two ways One, as logical formatting code when they help programs make sense out of the data. Two, as printer control code when they tell printers what-to-do.

While some codes are very technical and/or obscure, some are very interesting and useful. The most common ones are, Backspace (BS), carriage return (CR), line-feed (LF), etc.

A particular ASCII code value is able to give the full command like the code value '10' causes the printer to advance the

TABLE 13.4

ASCII control characters.

Binary code	Decimal code	Hex code	Control key	Name	Description	Command
(0000000)	0	00	^@	NUL	null character	CTRL-SHFT-P
(0000001)	1	01	^A	SOH	start of header	CTRL-A
(0000010)	2	02	^B	STX	start of text	CTRL-B
(0000011)	3	03	^C	EXT	end of text	CTRL-C
(0000100)	4	04	^D	EOT	end of transmission	CTRL-D
(0000101)	5	05	^E	ENQ	enquire	CTRL-E
(0000110)	6	06	^F	ACK	acknowledge	CTRL-F
(0000111)	7	07	^G	BEL	bell	CTRL-G
(0001000)	8	08	^H	BS	backspace	CTRL-H
(0001001)	9	09	^I	HT	horizontal tab	CTRL-I
(0001010)	10	0A	^J	LF	line feed	CTRL-J
(0001011)	11	0B	^K	VT	vertical tab	CTRL-K
(0001100)	12	0C	^L	FF	form feed (new page)	CTRL-L
(0001101)	13	0D	^M	CR	carriage return/enter	CTRL-M
(0001110)	14	0E	^N	SO	shift out	CTRL-N
(0001111)	15	0F	^O	SI	shift in	CTRL-O
(0010000)	16	10	^P	DEL	delete	CTRL-P
(0010001)	17	11	^Q	DC1	device control 1	CTRL-Q
(0010010)	18	12	^R	DC2	device control 2	CTRL-R
(0010011)	19	13	^S	DC3	device control 3	CTRL-S
(0010100)	20	14	^T	DC4	device control 4	CTRL-T
(0010101)	21	15	^U	NAK	negative knowledge	CTRL-U
(0010110)	22	16	^V	SYN	synchronize	CTRL-V
(0010111)	23	17	^W	ETB	end of text block	CTRL-W
(0011000)	24	18	^X	CAN	cancel	CTRL-X
(0011001)	25	19	^Y	EM	end of medium	CTRL-Y
(0011010)	26	1A	^Z	SUB	substitute	CTRL-Z
(0011011)	27	1B	^[	FSC	escape	CTRL-SHFT-K
(0011100)	28	1C	^/	FS	file separator	CTRL-SHFT-L
(0011101)	29	1D	^}	GS	group separator	CTRL-SHFT-M
(0011110)	30	1E	^^	RS	record separator	CTRL-SHFT-N
(0011111)	31	1F	^_	US	unit separator	CTRL-SHFT-O

paper by one line. Similarly, the code '12' causes the printer to advance the paper by one full page (it's called 'form feed'). The code '13' causes carriage return or returning of the print-head to the beginning of the line. The ASCII code includes 23 such control codes, which cause the printer to perform various operations. Since the codes are transmitted by the computer, the computer has a full control over the printer and the print format.

The primary and most important feature of ASCII code is that apart from alphanumeric characters (32-127), it covers a number of controls for the printer. These characters are very different from what they appear. They have very special use having no connection with their appearance. The 0-31 decimal codes are the 'how-to-print' part of ASCII set. These 32 codes are used to give commands or special information to the printer, or even to another computer through a telephone line and so on.

The computer has to, for example, tell the printer, from where to start, where the line ends, when to proceed to new page, when to start a new paragraph & so on. The printer should be able to advance the paper at the end of a line, set left and right margins, set tabulations and paragraphs, skip a page if required by the user, and so on. Such commands are covered in the ASCII characters Let us study table 13.4.

The second & third columns represent decimal and hex codes The fourth column is of our interest which against each entry shows a carat followed by a character. This actually means that if we press the control key provided on the keyboard alongwith a character in the fourth column, a command is keyed-in on the key board. Thus, by^0 we don't mean the carat character (^) followed by character 0. What we mean is control-0 which is keyed-in on the keyboard by holding down both the 'control key' and the '0' key simultaneously

The last but one column has the full description of the codes and last but two column has a two or three-letter code, which is a standard abbreviation for the full description of control. The abbreviated codes are often used in computer literature.

These 32 control codes are used in formatting of printed material They function in two ways. One, as logical formatting code when they help programs make sense out of the data. Two, as printer control code when they tell printers what-to-do.

While some codes are very technical and/or obscure, some are very interesting and useful. The most common ones are, Backspace (BS), carriage return (CR), line-feed (LF), etc

A particular ASCII code value is able to give the full command like the code value '10' causes the printer to advance the

TABLE 13 4

ASCII control characters.

Binary code	Decimal code	Hex code	Control key	Name	Description	Command
(0000000)	0	00	^@	NUL	null character	CTRL-SHFT-P
(0000001)	1	01	^A	SOH	start of header	CTRL-A
(0000010)	2	02	^B	STX	start of text	CTRL-B
(0000011)	3	03	^C	EXT	end of text	CTRL-C
(0000100)	4	04	^D	EOT	end of transmission	CTRL-D
(0000101)	5	05	^E	ENQ	enquire	CTRL-E
(0000110)	6	06	^F	ACK	acknowledge	CTRL-F
(0000111)	7	07	^G	BEL	bell	CTRL-G
(0001000)	8	08	^H	BS	backspace	CTRL-H
(0001001)	9	09	^I	HT	horizontal tab	CTRL-I
(0001010)	10	0A	^J	LF	line feed	CTRL-J
(0001011)	11	0B	^K	VT	vertical tab	CTRL-K
(0001100)	12	0C	^L	FF	form feed (new page)	CTRL-L
(0001101)	13	0D	^M	CR	carriage return/enter	CTRL-M
(0001110)	14	0E	^N	SO	shift out	CTRL-N
(0001111)	15	0F	^O	SI	shift in	CTRL-O
(0010000)	16	10	^P	DEL	delete	CTRL-P
(0010001)	17	11	^Q	DC1	device control 1	CTRL-Q
(0010010)	18	12	^R	DC2	device control 2	CTRL-R
(0010011)	19	13	^S	DC3	device control 3	CTRL-S
(0010100)	20	14	^T	DC4	device control 4	CTRL-T
(0010101)	21	15	^U	NAK	negative knowledge	CTRL-U
(0010110)	22	16	^V	SYN	synchronize	CTRL-V
(0010111)	23	17	^W	ETB	end of text block	CTRL-W
(0011000)	24	18	^X	CAN	cancel	CTRL-X
(0011001)	25	19	^Y	EM	end of medium	CTRL-Y
(0011010)	26	1A	^Z	SUB	substitute	CTRL-Z
(0011011)	27	1B	^[	ESC	escape	CTRL-SHFT-K
(0011100)	28	1C	^/	FS	file separator	CTRL-SHFT-L
(0011101)	29	1D	^]	GS	group separator	CTRL-SHFT-M
(0011110)	30	1E	^^	RS	record separator	CTRL-SHFT-N
(0011111)	31	1F	^—	US	unit separator	CTRL-SHFT-O

paper by one line. Similarly, the code '12' causes the printer to advance the paper by one full page (it's called 'form feed'). The code '13' causes carriage return or returning of the print-head to the beginning of the line. The ASCII code includes 23 such control codes, which cause the printer to perform various operations. Since the codes are transmitted by the computer, the computer has a full control over the printer and the print format.

Escape codes

Many printers provide special features like underlining, italicizing, double striking, boldfacing, etc., of the characters Some have capabilities to print graphics like pictures, graphs, drawings, etc. No single code in the ASCII group of codes can create such features. In fact, these operations are performed by using a combination of ASCII values in a predefined sequence.

The first value in the sequence is 27. This value is known as the 'escape code'. This value simply tells the printer that the value or values following '27' do not represent normal ASCII characters, rather, they would have new meanings assigned to them by the printer manufacturer.

For example, Epson printer code 52 preceded by code 27 means to create 'italics' (A normal ASCII code 52 represents the digit 4) However the same code 52, preceded by 27 in the Okidata printer means an entirely different command

Manual Controls

Sometimes, the user desires or requires to control the printer manually. Almost all printers have a switch or knob provided on the printer for selecting a form feed or a line feed. Some printers have what are known as DIP (dual-in package) switches for selecting a particular mode of operation. For instance, a single selection may underline whole print. Generally, these DIP switches can override the instructions from the computer. For example, the 'underlining' setting would ignore any contrary signals from the computer and keep underlining the whole print.

SELECTING A PRINTER

A few years ago, selecting a printer was an easy task. They were designed for large (mainframe) computers for heavy duty use. They were expensive, durable and reliable. Their qualities were directly reflected in their prices.

Today, micros have come in bulk. The market for printers for small computers is not like the earlier market for big computers Newest models with newest technologies are appearing every day and printer cost can vary right from Rs 3000/- to Rs. 1 0 lakh It is shocking to discover for a small computer buyer that a printer can ... even more than a micro. (It is like the stitching of clothes: the

stitching cost is more than the cost of the cloth!). So buying a printer for a micro is not an easy task.

The types of printers available in the market are extremely large and selecting a proper printer for your applications requires a lot of thinking.

Printers are generally independent of the rest of the computer system and they are quite interchangeable. It's very common that a micro user may buy a printer separately from a different supplier than the micro supplier.

The crucial questions to be answered at the time of selecting a printer are:

1. How good is the print quality?
2. How fast is the printing speed?
3. How much is the carriage width?
4. Compatibility with Hardware and software?
5. What are the special features?
6 What capability to print graphics?

Assessment of Needs

The first step in selection of a printer is the study of your applications & assessing your needs, short term as well as long-term. By proper assessment of your requirments, you can buy a printer which not only meets your present needs but can also be upgraded in future when the applications grow in number and complexity.

Some standard features are generally available in all printers (like bold-facing, underlining, headings, different type styles, and so on), but some features are specific to a printer. One can certainly get a printer with as many features as one likes but that would make its cost exhorbitant So it is more sensible to assess the requirements, which would help in selecting a printer with features most needed by you.

For instance, if your major need is word-processing, there is no point in going for a printer which can create high quality graphics. Or, suppose you have a computer with a parallel interface, you don't need a printer which has both parallel and serial interfaces, unless you are going to upgrade your computer by getting a serial interface also

Quality & Speed

Quality and speed have to be considered together. Generally, for a given investment, the higher the quality the lower the speed, unless you are willing to invest heavily on a printer.

In some applications good quality print is not a must. For example, if you are going to use the printer for listing of programs, for writing drafts of papers which would be used internally in the office, then, speed is important rather than the top quality. A fairly good quality printer would serve the purpose and a dot matrix printer with features of correspondence quality mode would be alright.

If you are a writer, you will have to print articles for sending to magazines. Print quality is very important and you should have it the highest. Speed is not that critical since you can engage yourself in something else (say writing) when the printer is printing A daisy-wheel printer would be a good choice for such an application. You need letter quality and not near letter quality printout, with each letter as one solid character. Also, different type styles can be created just by changing the print-wheel On the other hand if you are printing large manuscripts or do bulk correspondence, than a near letter quality dot matrix printer would suffice. You have to compromise quality for speed and price.

Printers are available which have about 200 cps speed in the draft quality mode and about 100 cps in correspondence quality mode. However, this is the rated speed of printers. The rated speed of a printer is the maximum speed. In practice, actual speed may be only 75% of this.

Some dot-matrix printers create a high quality printout by an overlapping dot-pattern. Different from the functioning in correspondence quality mode, in over-lapping mode, the printer prints one line of text and then reverts back and fills in the gaps between the dots. The text looks like the one typed from a typewriter. This printing is called near letter quality printing.

The quality of print from a dot matrix printer depends on the size of the dot matrix used for forming the character, whether it uses thermal or impact or some other technology for printing. A printer with 5 x 7 matrix would generate cruder looking printout a printer with 9 x 9 matrix

Most dot matrix printers can easily produce graphics since each dot in the matrix can be controlled independently. Many printers are available which can create and print all the graphic symbols used by the computer.

If noise is your primary concern, an ink-jet printer which is virtually noiseless would be suitable. Thermal printers being cheap are good for home applications.

Many printers serve some specific applications better than others. For instance, if word processing is your major application and you need high quality print for correspondence with the clients, then a daisy wheel printer is the best.

The daisy wheel printers are gradually being raplaced by near letter quality dot matrix printers.

Carriage Width

Standard spacing is ten characters per inch horizontally and six lines per inch vertically. Eighty columns 8½" wide paper is usually wide enough for many reports and letters. For schedules, statements of accounts etc. however, 132 columns on 15" wide paper or even more can be useful. Some printers offer 132 horizontal print position on 8½" wide paper by compressing the characters.

Compatibility

The printer you buy should interface with your computer and also with the specific software you plan to use. You should check that all three; the computer, the software & the printer work together in harmony.

If you have already decided on the application software and the computer, your choice of a printer is restricted since it must be compatible with the rest two items.

(i) Hardware & Interfaces: Some standards based on their popularity have been established for business computers & software by computer users all over the world. For instance, the centronics protocol is the standard for parallel interface and RS 232 C protocol is for serial interface. Diabolo software protocol for daisy wheel printers & Epson protocol for dot-matrix printers are also accepted by most computer manufacturers and software writers. Some printers use IEEE-488 parallel interface also. These

standards are very useful since they permit easy interfacing between the printer, the software & the computer.

A computer not using these standards would be very difficult to interface with a printer. Special cables and cartridges may be required for interfacing. Also the application programs developed for this computer may not support many types of printers, further restricting the choice of a printer.

(ii) Software: Some printers are capable of printing many type styles (for example graphics). This is generally activated by an application program. A printer without these capabilities cannot be used with the application program. It's therefore, essential to ensure that the printer selected is completely compatible with the computer and the application programs, and that required interfaces are included. In some graphics programs, a plotter rather than a printer is required (A plotter is a highly specialised machine giving high resolution printing and charting).

Graphics

Some printers are so versatile that whatever you see on the screen, can be created on paper by the printers If your screen can display tables, charts, figures and even pictures, the printer may be able to produce hard copies of them Generally dot-matrix printers have these features which are very important for applications where lots of reports, charts etc., have to be produced.

Standard Paper

Paper is a recurring expenditure on printing. It is very important to study the method your printer is using for printing and whether special paper is required for printing. Its availability and cost both have to be considered.

Some printers like thermal printers & electrostatic printers are cheap but they require special paper that costs more than the standard paper. Also, the paper is often difficult to find. We should therefore buy a printer that uses standard paper, the same paper as used by your typewriter, if you have one.

Also you should examine if the printer has a tractor feed or pin feed i.e., whether it can accept continuous paper or not, which may be required when you want to take a heavy printout.

Special Features

Specific commands to a dot-matrix printer can change the dot & dot density in the matrix. For instance, the dots can

be staggerred to create italics, or the space between dot columns can be varied to change the size or pitch of the characters. Some printers can print each character twice, with the dots on a slightly different position each time, to give sharper characters, i.e., a better quality print (correspondence quality). However, the characters always have to fit within the matrix of the printer, only the density & placement change.

We shall consider a few special prints & effects which can be created by changing the dot placement & density.

STANDARD

ITALICS

EMPHASIZED

DOUBLE-STRIKE

UNDERLINE

Fig. 13.10 Features of dot-matrix printers.

Correspondence Quality

The quality of print of a matrix printer in its normal mode is generally poor. The only advantage of normal mode is that it offers maximum speed & continuous printing. These normal printers are mainly used for internal documents & rough draft. They are relatively inexpensive compared to other types of impact printers & much faster than a daisy wheel printer. Some matrix printers in draft quality mode can print at more than 200 cps.

Some printers can be operated in what is called the correspondence quality mode or the near letter quality printing mode (NLQP) Printing is quite improved in this mode, it looks more professional type & is good for manuscripts, correspondence &

other applications requiring high quality print. Of course, the print quality is not as good as that of a typewriter but it's a good compromisation between speed & price. The speed is high & the cost is low compared to say a daisy wheel printer. Most dot matrix printers, in this mode, can print 50 to 100 cps compared to daisy wheel printers which print only from 30 to 40 cps.

The quality of print in correspondence mode differs from printer to printer. Some are available in which characters appear almost fully formed. The buyer has to decide the level of quality acceptable to him viz-a-viz cost of the printer.

Pitch, Font & Type Styles

Pitch means the number of characters per inch (cpi). The larger the size of the characters the lesser the pitch, i e. the lesser the number of characters that can be printed in one inch. Also, lesser the spaces between the characters, the higher is the pitch.

Most dot matrix printers give you a wide choice of spacing between characters. A standard line of a typewritten page has about 70 characters while computer printers can print up to 132 characters in a line. The standard pitch is usually

(i) 10 cpi (called pica, 80 characters per standard 8" line),
(ii) 12 cpi (called elite, 96 characters per standard 8" line) &
(iii) 15 cpi (called micro, 120 characters per standard 8" line)

The printers generally offer from 5 cpi (double width) to 17.5 cpi (compressed). The pitch of 17 cpi would give 132 characters per standard line.

Changing of the pitch requires the matrix colums to become closer or farther, narrowing or widening the matrix width but the height of the character remaining unchanged.

Font: It refers to style of printing. Some printers offer double width, also called expanded font. This requires printing of one character twice with the same dot density. The second printing is at normal spacing to the first. Columns are so adjusted that the character width is twice that of normal characters.

Some printers offer printing in italics which is a frequently used style for emphasis of certain words in the text. It is printed in the same manner as ordinary characters.

In a daisy wheel printer, the italic would be provided through change of a print wheel whereas in a dot matrix printer, one

has to only send an appropriate control code to the printer. In a dot matrix printer, the dots are staggered.

Some printers offer a number of choices for pitch and type-styles. Some can even print letter in reverse format. That means the character is left white, whereas the area around it becomes black. Others offer only a small selection. When selecting a printer you must examine the availability for your applications.

Bold-Facing & Double Strike: Many printers offer these features. The effects are created by a software which sends necessary commands to the printer.

The double-strike gives a dark print. Each character is printed twice, appearing darker than the rest of the text.

Boldfacing is obtained by making the diasy-wheel or the dot-matrix wires hit the ribbon twice, the second hitting slightly shifted from the first. This printers a double but solid image. Excellent bold-facing presents a very appealing text.

On less advanced printers, the boldfaced character can show twoseparate images, giving it a smudged appearance.

Underlining: Characters are underlined as they are typed so that one does not have to go back & do the underlining after typing the characters/words to be underlined To highlight some portion of the text, underlining is very useful & indispensable.

In a dot-matrix printer, the underlining is done with the last pin in the column matrix. This last pin is the same which prints decenders of lowercase letter like 'y', 'g', etc. Some printers underline characters only, leaving the space between characters not underlined.

Proportional Spacing: Ordinary typewriters use the same space for each character, irrespective of the width of the character. In such prints, a narrow character like 'i' has a larger gap around it than a wide-character say 'W'. The text is not very appealing to the eye.

In proportional spacing, the space occupied by a character depends on its width. It spaces typed text such that 'fat' letters like 'w' are allocated more width than 'slim' letters like 'i'. It gives better appearance to the text. This feature provides neater and more compact printout. The number of characters per inch are not constant. They vary in proportion to the individual sizes of characters

Technically, this feature is known as downloading. It permits creation of special texts such as italics, Gothic & foreign language set. The printer may not be having such characters but the program generates the special characters This facility is very useful in applications like wordprocessing, designing, graphics etc

Self Test: Some printers have a self-test feature that allows you to let the printer test all of its functions automatically. You simply have to press a couple of keys The self-test feature is very important to determine whether the problem exists in your computer or in the printer If your printer has any problem, it will be printed out exactly and corrective measures can then be taken Without this facility, one may have to waste a long-period in even detecting a fault.

Printer Supplies

The Printers need four types of supplies:

1. Paper or forms.
2. Ribbons.
3. Print wheels or daisy wheels.
4. Fuses.

They all cost extra. The running cost of a printer should be an important criterion for selecting the one. Consumables like ribbons may cost a lot if you buy a wrong model. In fact, you must check up on the cost & availability of each of the supplies before buying a printer. Let's examine them one by one:

1. Paper

Paper for the printer comes in various qualities, width & prices. The size you should choose depends upon your requirements. You should buy a size often used by you & as much as possible, should try to standardize one or two sizes for all your needs.

Quality of the paper also depends upon your applications Paper is also available in multilayers with carbon inserted beforehand or with automatic carbons which is good for applications like invoicing etc. Of course, this type of paper is much costlier than ordinary paper but it saves time & efforts in obtaining multiple copies.

Normally printers use roll paper & fan-fold paper.

an-Fold Paper is the one which comes in continuous reams, with izontal perforations after every page-length. The paper is

continuously fed & is automatically folded along these perforations to make stack which unfolds when the paper is drawn through the printer. Both the left & right extremes of the paper are punched so that the holes can fit into the teeth of the printer roller.

The advantage of continuous feed paper is that if one has to print 20 pages, one can tell the computer to print out all 20 pages at once & not insert sheets one by one as is done in case of normal office typewriters.

Feeding of Paper

In normal typewriters, the paper is fed by application of frictional pressure against the paper & roller. Friction feed is good for a typewriter which types sheets of smaller lengths. If sheets longer than this are used (say a sheet as long as 10 normal sheets), the whole length of sheet may not pass through the roller without getting out of adjustment.

To aviod this, computer printers have facilities so that long or continuous sheets can be used conveniently. Two technologies are employed.

(i) **Pin Feed Platen:** The platens contain small pins that catch in the holes on the sides of continuous paper, & pull the paper through the printer. You need a different size of platen for each size of paper.

(ii) **Tractor feed:** Tractor feed attaches to the printer over the platen & uses the holes on the sides of continuous paper to pull the paper through the printer.

The edges of the paper containing the holes can generally be removed along vertical perforations so that you end up with standard sheet or paper.

Preprinted Paper

Preprinted papers/forms are used for letters, billing, statements etc

Three types of printed forms are possible.
1. Single sheet regular forms (like letter-heads)
2. Forms stuck to continuous paper.
3. Forms printed onto continuous paper.

Regular letterheads/forms need no elaboration. They are used like they are used on ordinary typewriters, except for the difference

that they may be fed in the computer printer automatically one after the other

Sometimes, letterheads/envelopes/forms etc. can be glued to a continuous roll or fan-fold paper. After going through the printer & printing of required matter, these forms are separated from the continuous paper manually or automatically by another machine.

Often, the forms are directly printed on continuous paper & typed. The paper supplier or stationary printer can supply you such papers as per your required format.

Labels

Labels are required, say for printing of individual addresses on the mailing list. Different sizes & shapes are available. They are attached onto continuous paper & separated after printing. Also more than one label (often up to 4 or 6) are put in one line so that all of them can be printed in one go, saving printing time.

Labels may be adhesive or non-adhesive depending upon the kind of application. For mailing list, adhesive labels are useful.

Ribbon Replacement

Most printers use the ribbons specialy designed for them. Often, they would we available only with the printer supplier, who charges exhorbitantly due to monopoly. However, more & more 'compatible' printers are coming to the market, so that ribbon suitable for one model, are also suitable for others & can be exchanged Also some sort of standardization is slowly being adopted so that third parties have started manufacturing & selling them. They generally cost less than what you have to pay to the printer supplier

So, before you buy a printer, the 'ribbon' factor has to be evaluated. To save on ribbons,& therefore on the running cost of your printer, you should answer the following questions:

1. You should think of the ribbon cost before buying a printer & not after One way to compare various options is to calculate the cost of typing of say 1,00,000 characters, for the type of ribbons (whether correctable or multistrike or fabric etc.) you ould be using

2. Ribbons *Three types of ribbons are normally used:*

1. Carbon correctable
2. Fabric
3. Multistrike

Their advantages & disadvantages are compared in the table below:

Table 13.5 comparison of different ribbons

Characteristic	Carbon correctable	Fabric	Multistrike
Reusability & life	One-time use hence, limited life	Reusable hence, lasts longer	Reusable
Quality of first print	Good	Moderate	Good
Cost	High	Cheaper	Medium
Repeatability of print	As good as for first time	Becomes less dense with each use	Moderate
Application	Good for original copy	Good for draft work	Good for general purpose
No. of characters	about 100000i.e. about 50pagesof 2000 characters	Unlimited	Unlimited
Refilling/ Rewinding	Refilling possible	Rewinding possible	Rewinding possible
Sudden stop	Possible	not much	not much

Generally a correctable ribbon used on Electronic Typewriter costs about Rs. 100 & can print about 1,00,000 characters. To have *an insight into ribbon costs, let's study the following example.*

If everyday you type about 40 letters of average 1000 characters each, you are printing 40,000 characters daily or 1,00,000 characters a month, considering 25 working days in a month. A correctable carbon ribbon costing about Rs. 100/- can print approximately 1,00,000 characters. Thus you need, 10 ribbons a month i.e. you have to spend Rs 1000 *per month just* on ribbons. At this rate, you would spend Rs. 24,000/- in two years; sufficient money for another good printer!

(A normal ribbon is about 300 metres long i.e. round about 10,000 inches. For 10 characters per inch, it can print a total of 1,00,000 characters.)

2. Whether the ribbon used on the printer is a 'standard' one? As far as possible, you should not be restricted to use of only the 'own-brand' of the printer suppliers. If a printer uses special ribbon cartridge, it may be costly & not easily available. The other printer, using a regular typewriter ribbon may be cheap & available locally. The brand which your printer needs should be economic & available openly, locally & in plenty. Spare ribbons should be available to the user since the present stock may be over earlier than expected.

Fortunately, a federation of dealers & manufacturers called OMEF (Office Machines & Equipment Federation) is trying to lay down codings for each model of printer & the ribbon it uses. Thus, if you know the 'Code number' of the ribbon used on your printer, any ribbon available in the open market bearing this 'code number' can be used on your printer.

3. Refilling: Some printer suppliers use ribbon cassettes for correctable carbon ribbons in which the ribbon can be removed after use & a new one, also called a pancake, inserted. This can save the cost on ribbon to a large extent. A pancake may cost about Rs. 30/- to 40/-.

4. Quality of Print: Cloth ribbons which are much cheap compared to carbon correctables, should preferably be used, unless very high quality of print is required. Your printer should be able to use carbon ribbons. Bi-colour & multi-colour ribbons are also available.

5. Also it should be checked that ribbon change on the printer is clean & easy to make by the user.

3. Print Or Daisy-Wheels

Daisy-wheels are normally bought at the time of purchase of a printer & generally last long. However, breakage is possible & you may have to buy them from the printer supplier. Spare daisy-wheels should be available easily & as much as possible, from other sources also than the printer supplier alone.

They should be stored in special storage boxes available in the [illegible] or with the printer supplier.

4. Fuses

Spare fuses should be easily available to the user since they may be required for replacement any time.

Storage of Printouts

Special storage racks are available to properly store the printouts from computer

14.
Graphics Printers & Plotters

Graphics

The term 'Graphics' is used to mean graphs, charts, designs, tables, etc. The numerical data represented in the form of graphics is very appealing to the eye & it also makes understanding of comparisons very easy. It's a very important aid for non-technical staff who can be made to easily grasp the technical and complicated relationships between various parameters, through graphs *and charts The material presented to the audience becomes more* interesting and can convey ideas more conveniently

Application programs which can generate graphic displays on video screens of micros are available in plenty These displays are produced with the help of input devices like joysticks, graphics tablets, light pens, the keyboard itself, and so on. These programs, with the help of a printer, also permit a hard copy of the design displayed on the video, provided the printer is capable of creating graphics

The printing of a graphical video display is quite different from the printing of a text display. A printer prints a character in the text by recognizing the ASCII code for the character and prints the pattern of dots stored in the character generator chip. The graphics is generally created by controlling each and every dot individually and therefore, the printer needs the information from the computer about the exact location of every single dot comprising the display If the video can display 1,28,000 dots, individual information about all these 1,28,000 dots has to be given to the printer for obtaining a hard copy of the display

A printer used for text printing is generally not suitable for printing graphics. The opposite is also true that the printers which can produce good quality graphics are unsuitable for printing of text.

The technological developments during last few years however, have changed the scene quite a lot Some dual purpose printers,

like laser and ink-jet printers, are available which can be used for both applications, the text and the graphics, of course, in monocolour. Such printers which handle both letter quality printing and graphics, however, are very costly.

Graphics with Dot Matrix Printer

The dot matrix printers, with the help of suitable graphics application software, can create graphics which consists of hundreds of tiny dots in each line. A dot-matrix printer is dot addressable meaning thereby that the user has complete control over each dot for placement on the paper.

Let us see how graphics is generated by a dot-matrix printer. The video display can be divided into a number of horizontal segments (also called lines), each segment having a number of dots in the vertical width. The computer sends information about the first vertical line of the segment. The process continues for the whole segment till the last vertical line is printed. The head returns to the beginning and the paper advances just enough for the head to come just below the first segment (or line). It is now ready to print the second line and so on, till the entire display is printed.

The quality of graphics generated would be decided by dot-density, i.e., the number of dots per inch (dpi). Higher the density, better the graphics created. At high densities, you would not perceive individual dots but perceive a continuity in dots. With dot matrix printers the density varies from 60 to 240 dpi. The graphics quality from these printers is mediocre. The greatest advantage in using a dot matrix printer for graphics is that, in addition to creation of graphics howsoever crude, it can also be used for printing text. Hence, it is most widely used for general applications requiring printing of both text and graphics at low costs. Of course, one has to compromise on quality.

Graphics with Daisy Wheel Printer

Even daisy-wheel printers have some limited capabilities to generate graphics. With the help of suitable application software, very small (microspacing) horizontal and vertical movements of the print-head can be achieved. The printer can be controlled to print specified characters at specified locations on paper to create designs. The graphics created is generally unsophisticated & crude in appearance.

Some daisy-wheel printers, depending upon the model, can be fitted with daisy-wheel with special characters and typestyles, very much like graphics characters, so that the quality of graphics is improved.

PLOTTER

The printers like dot-matrix and daisy wheel printers are suitable for many general purpose applications including graphics printing. However, they create graphics on only one media which is paper To have professional quality graphics with continuous curves & smoother lines, & with a choice of various media, an altogether different device than printers is used. This device is called a plotter.

A plotter is an output device which is used to draw figures, graphs, design & illustrations, under the control of computer to which the plotter is linked.

Many plotters use coloured pens to draw coloured designs. They create graphics on papers which cost much less than having them produced commercially Hence, they are vesry much used by computer users.

Earlier plotters were very expensive and were used only for advanced applications such as engineering, research, computer-aided manufacturing (CAM), computer-aided design (CAD), etc. It is only very recently that they have become popular even with small computer users, due to lowering of plotter prices. Another important reason why plotters have clicked with personal computers is that plotters can be easily linked with the ,personal computers

Like on large computers, on small computers also the plotters can easily create graphs, charts, figures, etc., of professional quality They can draw graphs in ink, on variety of media, and in variety of colours.

Plotters are quite easy to use. They are driven by the application program used to create data for the plotter. Number of standard graphics application packages are available readymade in the market. For instance, one can create data through database, spread-sheet, business graphics, or many other application software. Through a plotter, this data can generate graphs, charts and tables rapidly, often in a matter of minutes

The plotter is a very convenient and invaluable tool in business graphics applications. It can be used as easily as a printer. The added advantage with a plotter is that its output is a step higher for data analysis and presentation, compared to a text output from a printer.

Working of a Plotter

A plotter is like a printer to some extent Both can give output on paper. Like a printwheel in a printer, the plotter has one or more arms, each of them carrying an ink pen and move across the paper to draw.

The arm movement is controlled by a microprocessor (chip) It can very precisely move to any point on the paper placed below.

Manipulation of arm movements is decided by the computer data and the software under use. Various geometrical shapes like lines, curves, squares, circles etc can be generated

Types of Plotters

Micros generally use two types of plotters. Flatbed and Drum plotters

Flatbed Plotters: It has a flat base like a drawing board on which the paper is laid flat. An arm containing the pen moves over the paper The arm can move in two directions, one parallel to the plotter and the other perpendicular to it (called x & y directions). With this kind of movement, any point on the paper can be approached by the arm.

The computer sends the commands to the plotter which are translated into x & y movements. The arm moves in very small steps to produce continuous & smooth graphics.

It has the advantage that the user can easily control the graphics He can lift the arm along with the pen any time (even during the production of the graphics) and manually take it to any position on the paper, so that the position of the graphics can be altered as per his choice. The disadvantage is that a flatbed plotter occupies large space.

Drum Plotters: Compared to a flatbed plotter, a drum plotter is very compact and light weight. In this plotter, instead of movement of arm in x & y directions as in a flatbed plotter, the paper is moved by a drum. The arm carrying a pen moves only in one

Some daisy-wheel printers, depending upon the model, can be fitted with daisy-wheel with special characters and typestyles, very much like graphics characters, so that the quality of graphics is improved.

PLOTTER

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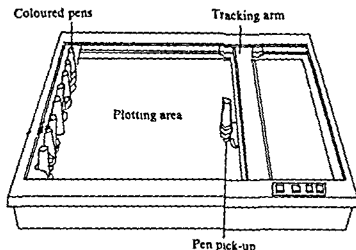


Fig 14 1 Flat Bed Graph plotter

direction, perpendicular to the direction of motion of the paper. The combination of pen & paper movement creates graphics. The paper moves back & forth to draw a continuous curve or line.

The disadvantage is that the user can't freely control the graphics when it's being created.

Plotter Features

Plotters can have a number of features. It is important to understand them so that one can select a plotter with required features.

Pens: Plotters can use a variety of pens like ball point, soft-tip, ink, sketch & so on. Even a carbo[illegible] is usable. The[illegible] create very smooth and superior [illegible] wings and [illegible] compared to what is produced even [illegible] Plotters can also produce a [illegible] Mod[illegible] available which can hold more [illegible] eight [illegible] possible simultaneously. This [illegible] for [illegible] multicolour [illegible]

Media: Plotters use a variety of media to produce designs and graphics. Right from ordinary paper to transparencies, vellum, Mylar, glossy paper and so on. The quality of production would depend upon the type of media used. The kind of application would decide what media you should use. If you have to often present a lot of charts and figures to some audience, then transparencies are good since they can be easily shown with the help of a projector. Similarly, if you need to store graphics for a long time, good paper or even mylar may be a good choice.

Resolution: Resolution for a plotter simply means the smallest move a plotter can make. Technically, it refers to a number of distinguishable points that can be put in a unit length say an inch or a millimetre. Low resolution would make the arc, curve, circle, etc , appears as made up of tiny but separate lines. The diagonal lines will have staircase appearance. (One can also see the 'staircase' effect on video screens with low resolutions).

Higher the resolution, finer the graphs & charts produced by a plotter.

Repeatability: This refers to the plotter's ability to return to a point. If it's poor (say 0 1 mm or more) then it will not be able to properly close the circles, boxes, etc. Even the graphs would have lines with varying thickness.

Graphics: A plotter drives its graphics capability from the software within the plotter. It has to have the information about the direction, shape, size and position of the drawing.

The graphics capability differs from plotter to plotter. Most of them can handle basic geometrical shapes like curves, arcs, circles, triangles, squares, straight lines, broken lines, etc. They can create standard graphs and charts for business & other applications. Some plotters can produce line drawings, blue prints and even CAM/CAD designs Plotters produce these effects with much high resolution than the printers.

Input Data: Input data refers to the code that the plotter can understand. Most micros transmit data in ASCII code, so the plotter should also accept ASCII codes as its input data. Such a plotter can be easily connected to a micro. However, a plotter designed to work both with a large computer and a minicomputer may not use ASCII code for data transmission and therefore, it will not be suitable for a micro using ASCII code So, one has to be careful in selecting a plotter. It should be ensured that it has same input data code as your micro.

Plotter Area: Depending upon your size requirements, you would need a plotter which can draw on papers of sizes selected by you. A number of sizes of papers are available in the market. Either on a A, B, C, D, convention or A3, A4 etc. convention, you would have to decide upon paper sizes & then decide on a plotter.

Speed: Speed is important for a frequent user of a plotter. However, defining & determining speed of a plotter is very tricky. Most manufacturers may tilt the definition to suit their advantages. The plotter is not like a printer where printing of each character takes almost same time The time a plotter takes to plot certain figure depends upon,the complexity of the figure, the mechanical movements of the plotter, the graphic language of the plotter etc. What the manufacturers may claim is generally, the speed of the arm holding the pen & that too for straight lines & diagonals.

If the pen/s can be changed fast, the overall speed & through-put from the plotter would increase. Likewise, the technique of paper installation, paper feeding, paper movement are also the factors affecting speed of a plotter.

To compare different plotters for their speed, you should draw a standard graph/figure on all of them & make comparative assessment

Graphic Language: The plotter starts drawing after receiving commands from the computer to which it is attached. These commands decide whether the plotter has to move, rotate, draw characters, draw circles & so on. These commands or subroutines are permanently built into the ROM of the plotter & are collectively known as graphics language, much like an operating system with the computer. The operating system as,we might recall, coordinates & directs the operations of the computer on receiving commands from the program or via the keyboard.

The graphics language decides which application software would be compatible or whether you can run your own programs. The command set of one graphic language differs from the other & may be,the spreadsheet or database or graphics programs which are compatible with one plotter, are not compatible with another. Therefore, if you have a particular application or program in mind, you must ensure that it would be compatible with the plotter you are going to buy.

Some standard graphics language protocols are HP/GL (Hewlett Packard Graphics Language), DM/PL (Digital Microprocessor Plotting Languages) etc.

15.
Interfaces

Computers, to be of any use, must communicate with peripheral devices such as printers, videos, modems, etc. The term Interface refers to the equipment that connects two or more different computer devices. Also called an Input/Output port, an interface connects the CPU & the memory of the computer to the peripherals attached to the computer.

A peripheral interface can be a single chip or an entire circuit board, depending on how complex the functions it has to perform Its job is to direct input and output traffic of the computer as data moves to and from the various peripherals. It performs translation of the data so that the CPU can understand the input data and the peripheral device can understand and accept the output data. For instance, it enables a computer to transfer information to a printer.

To simplify and standardized the inferfacing, standards have been developed and accepted all over the world. They define how the data is to be transferred. Most microcomputers have a standard interface or I/O port for attachment. Two devices using the same standard should work together properly. The computer which has no standard ports, would cost heavily to enable it to use a printer or other peripheral device.

Interface Standards

Let us discuss the three most commonly used interface standards which are:

1. The Centronics parallel interface.
2. The RS-232 C serial interface &
3. The IEEE parallel interface.

All are industry standards and are used by manufacturers. However, there are many variations in practice.

One need not know how an interface works but the advantages and disadvantages of each should be understood for proper selection of devices like a printer, modem etc.

The particular devices attached to the computer decide what interface is required. Some devices can use 'parallel' as well as 'serial' interfaces, the printer is a famous example.

Interface cards can be used to convert from one interface to another whenever required for interchangeability.

Before discussing about the interfaces let us define a few terms connected with interfacing & transmission.

Parallel & Serial Transmission

There are two different manners in which data can be sent and received to and from the CPU and the peripherals.

1. Parallel and
2. Serial

Parallel transmission means that 8 data bits representing a character are sent to receiving device, over a set of wires, all at one time. In serial transmission each of the 8 bits are sent one at a time, all using the same single wire.

Serial transmission is simpler, slower, more flexible and usually cheaper than parallel transmission. It is generally used when peripheral is located at some distance from the CPU since cables for parallel transmission are very expensive.

Parallel devices usually operate with one specific system. Devices that use parallel transmission are typically high speed peripherals such as disk and tape drives. Some devices like CRTs, keyboards, and printers can use either transmission, parallel or serial. Therefore, while selecting a computer system it is necessary to know the specifications of the peripherals that are going to be used.

Handshaking

The transfer of data from one device to the other is a slightly complicated process. The devices have to properly coordinate their activities for successful transfer. For example, when two devices operate at different speeds, the faster of the two has to pause intermittently so that the slower one can catch up with the faster one. Handshaking is a sort of mutual agreement, consisting of some exchange signals, for control of transmission.

Synchronous & Asynchronous Serial Transmis[illegible]

Serial transmission is possib[illegible]

1. Synchronously
2. Asynchronously.

TABLE 15.1

Comparison of Serial & Parallel Transmission

Parameter	Serial	Parallel
Efficiency	Lower	Higher
Process of transmission	One bit at a time	8 data bits at a time
Speed	Low	High
Cost	Cheaper	Costly
Useful when	Peripheral is at distance from CPU	Peripheral is near to CPU
Used with	CRTs, keyboards, printers etc	Disk & tape drives specially & also CRTs, keyboards, printers etc.
Standard	RS-232-C	'Centronics' parallel & IEEE
Flexibility with different makes	Can use printers, terminals & other devices of different makes	Operates with one specific system.

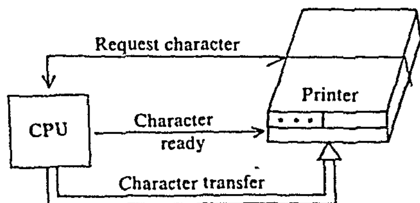


Fig 15.1 Handshaking

1. In synchronous transmission, the bits are sent in a regular pulse. This requires complete synchronization of the peripheral interface and the receiving device (the peripherals) with each other. The pulses are counted and accumulated into characters. When the CPU has no data to send to the device, the device sends synchronizing characters to keep its timing right.

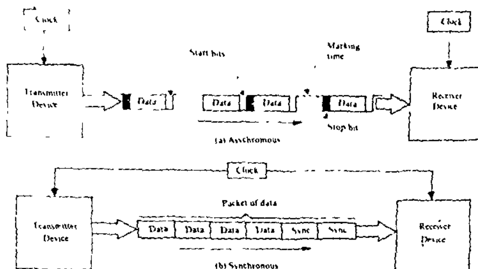


Fig. 15.2 Asynchronous & Synchronous transmission

2. Another method of serial transmission is asynchronously. The beginning and end of each character (byte) are marked by start and stop bits. This way the data can arrive at any time since each character is identifiable as a separate character any time. The receiving device recognizes the start & stop bits, counts the bits in between & recognize the character as it arrives.

Centronics Parallel

For parallel interfacing no other interface has received such wide popularity as Centronics parallel. Centronics, a printer manufacturer, had developed it for its own printers. It was subsequently accepted as an 'industry standard'.

1. It defines the use of 36 lines
   (i) 8 lines for parallel transfer of data.
   (ii) 3 lines for control & handshaking
   (iii) 25 lines for information about simplest applications & uses by various printers. For example, information that the printer is on-line, or the printer has an error, or the paper is over, & so on.
2. This interface permits a maximum of 5 feet cables for connecting to devices.

Transfer

The handshaking lines control the exchange of data The three lines are:

(i) data-strobe line
(ii) acknowledge line (ACK) &
(iii) busy line

The process of transfer of a byte from a computer to printer is something like this The computer selectively activates the data lines corresponding to a particular character. The data-storage line is also simultaneously activated. The printer then activates the busy line to inform the computer that the printer is accepting the data & the computer should stop sending further data Once the printer has received the character, it activates acknowledge line & deactivates the busy line. Recognizing the acknowledge signal the computer knows that the transfer is complete & it starts sending the next character & the whole process is repeated for the next characters. If at any time in the process, there is a delay with the printer, it simply activates the busy line & the computer pauses.

RS-232-C Serial Interface

RS-232-C (RS standing for recommended standard) was adopted by the Electronic Industries Association (EIA). It has become the most common voltage standard for serial transmission on printers & modems. The standard ensures uniformity of interface between data communication equipment and data processing terminal equipment. It is accepted by most of the manufacturers all over the world.

The standard specifies the voltage levels for signals exchanged between the devices. It specifies what voltage is required to define a 'o' or 't' so that the device can distinguish data from noise on the line.

RS-232-C is more common for micros. It's used for 'serial' devices, the most common among them are printers and modems.

The serial transmission in general is inefficient compared to parallel transmission. However, it is very advantageous for long distance transmissions, much better than parallel transmission.

RS-232-C, in particular, is efficient for long distance interfaces transmission due to the fact that it involves fewer lines & less bulky cables compared to other parallel interfaces. Transmission up to 20 metres can be made with simple cables. For higher distances, modems in place of wires are the best. It is good for distance transmission such as that required in telephone

RS-232 C Parameters leftout

Although the hardware requirements for RS-232 parallel interface are quite clear, this interface does leave some questions unanswered about some important issues. Some parameters are left undefined. For instance,

1. What is the data transfer rate?
2. How would the separation between bytes of data be recognized?
3. How many bits does a word have?
4. Full duplex or half duplex
5. Parity check, & so on.

The parameters have to be agreed upon by all the three, the device to be connected, the computer and the software, before transmission takes place.

(i) Baud rate: The lines in RS-232-C only open up the gate for data transfer, they don't control the rate of data transfer. Some devices can transmit and receive data faster than others. For instance, a printer generally prints data very slowly whereas a video display unit displays the characters as soon as they are entered through the key board.

(ii) Separation of bytes: In serial transmission, the receiver has to know the beginning and end of a byte. To clearly distinguish, the sender inserts start and stop bits in the formation of the character. Generally, either one or two stop bits are used but the transmitting and receiving devices must agree on this number prior to transmission..

(iii) Size of data byte: The ASCII standard uses seven bits for representing alphanumeric characters but other codes may use a different number. The number of bits used for a character is called 'word length'. The serial transmission involves the disassembly of bytes of data & for correct reassembling of bytes, an agreement on byte size is vital.

(iv) Full Duplex and half duplex: This parameter decides whether the transmission is one-way or two-way. RS-232-C permits transmission and reception of data on separate lines. This is called full duplex mode and is useful for modems and terminal, since they can transmit and receive simultaneously. However, for some [illegible] specially with printers, the half-duplex mode is more [illegible]s, permitting transmission in only one direction.

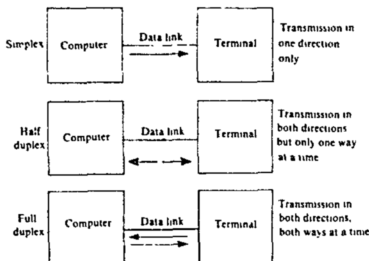


Fig 15 3 Simplex, half-duplex, and full duplex communications

IEEE-Parallel

Scientist & Engineers were the first to use the computers in early 1970s. One of the greatest problems they faced was how to successfully interface the equipment from earlier manufactures. The earlier computer peripherals, manufactured for one computer, could not be easily linked to work with another computer. Lot of 'incompatible' devices were manufactured.

To overcome this incompatibility,the Institute of Electrical & Electronics Engineering (IEEE) proposed a parallel interface which was later approved by the American National Standards Institute (ANSI). The interface is mostly known an IEEE standard, however, it is also known as GPIB (General Purpose Interface Bus) & HPIB (Hewlett Packard Interface Bus).

Some of the features of this standard are

(i) It defines a parallel transmission. The most common parallel device for which it's used is a floppy disk drive.

(ii) It permits connection of upto 16 devices on the single common cable, each device distinguished by a separate 'address' number.

(iii) For efficient data transfer the maximum combined length of cables between devices should not exceed 20 metres or twice the number of devices, whichever is less. Thus, if 7 devices are connected, the total cable length permitted is 14 meters.

(iv) the rate of data transfer is higher than either RS-232 C Centronics Parallel.

(v) the data is transferred by means of adoption of three roles by the devices, that of a 'controller', a 'talker' & a 'listener'. Generally, the host computer takes the role of a controller & can direct any other device to take any role, a talker or a listener.

The talker supplies data to the common cable & the listener picks up data from the cable.

(vi) This standard does not need other parameters like parity, baud rate, etc., unlike RS-232 C where they must be defined.

(vii) In spite of its positive features, very few manufacturers of computer devices, except for Hewlett-Packard & Commodore, have adopted this standard. The main reason is that Hewlett-Packard has got proprietary rights over the three-line handshaking (Controller, talker & listener) protocol.

16
IBM-PC & Compatibles

IBM has introduced a class of microcomputers. The one based on 8088 chip & released in 1981 is known as a IBM-Personal Computer or IBM-PC. Since the introduction of PC, it has become the most popular & useful computer all over the world. Millions of people are using them. The PCs are versatile, easy to operate & thousands & thousands of people & companies have written application programs for it. A number of new hardware suppliers have been born selling their products independently for use with PC.

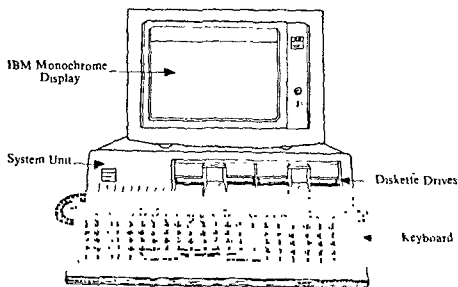


Fig 16 1 The IBM Personal Computer

IBM has introduced four personal computers

(i) IBM-PC
(ii) IBM-PC/XT
(iii) IBM-PCjr &
(iv) IBM-PC portable

They differ in price & capability. Each can be used in business, home, education & numerous other applications. We shall be primarily discussing IBM-PC, the most representative PC among all four In fact, many computer programs run on all the four systems. Differences among the models include storage capacity, video screens, keyboards, expansion capabilities etc.

The entry of PC has been a very significant event. It is sold at a prive low enough to be brought for home use, but powerful enough to run a business with. No longer can a computer professional boast that his computer is superior to another computer run by a school boy. The heart of both the business computer & the personal computer is the same, very powerful, very cheap, square of silicon about 2 mm across. The distinction between 'personal computer' & 'business computer' is disappearing.

The progress in PCs since 1980 have been astounding. Someone has estimated that if the aeronautics industry had progressed as quickly as the computer industry over the past 40 years, airplanes would cost a few thousand rupees.

PCs are powerful, dependable & inexpensive. In word processing, accounting, cost projection & several other key areas of business & administration, a PC will pay for itself in less than six months. It is a machine that sits on virtually every desk & has become so common place as to be ignored.

A PC can sort a list of 10,000 names & addresses into pincode order. The same list it can sort again into alphabetical order. It can separate by state & list alphabetically within each state & so on. All permutations combinations are possible.

PC running a word processing program is a word processing computer; the same PC running an accounting program, is an accounting computer and so on.

PC System Components

A basic PC-system is shown. The various possible components, add-ons etc., are shown in block diagram.

We have covered most of them in concerned chapters. We shall reproduce & briefly discuss some of them here for the sake of ready reference.

The PC Microprocessors

Intel 8088 : This is the chip which IBM chose for its personal

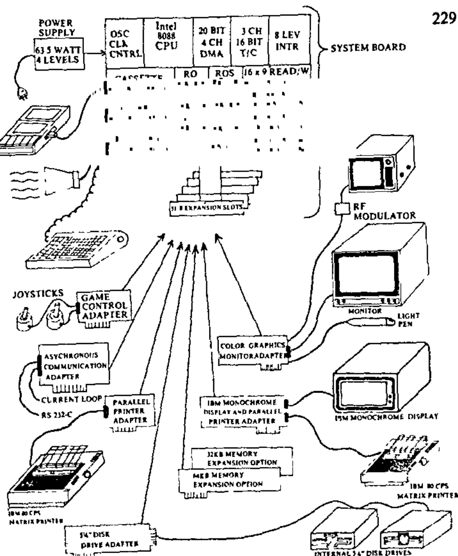


Fig 16 2 Block diagram for the IBM Personal computer System

computer. Intel's 8088 microprocessor is unusual. It has the attributes of both 8 bit & 16 bit chips. It combines the increased capabilities of a 16 bit processor which can communicate with an 8 bit world. *It is more powerful than 8 bit but the least powerful* among the 16 bit processors. It is referred to as an 8/16 chip to distinguish it from the 'truer' full 16 bit chips, such as Intel-8086.

Use of the 8088 chip allows the IBM-PC to be compatible with both the standard 8 bit (like 8080/8085 chips) & 16 bit (like 8086) hardware and software currently in use.

Because of its 8-bit external bus, the 8088 can use 8 bit support chips, a fact that adds to its cost effectiveness, a primary consideration in IBM's selection of this chip.

The 8088 (& also 8086) chip has 1 Mb direct addressing capacity with a 20 bit address bus. It also provides, 24 operand addressing modes, 14-word by 16-bit register set with symmetrical operations, as well as byte, word and block operations.

The 8088 is divided into two separate processing units:

1. Execution unit carries out all instructions.

2 The Bus Interface unit fetches instuctions and move data between the 16-bit internal bus and the 8-bit external bus. This enables the 8088, and its full 16-bit brother, the 8086, to perform its computing functions internally while it's busy fetching and sending data back and forth. In other words, while the 8088 seems otherwise occupied by communicating with its 8-bit external environment, it is still doing its work within the internal 16-bit processor. This means that the 8088 is a faster microporcessor than its grandfather, the 8080.

IBM's entry into the micro market with the adoption of 8088 for its IBM-PC made a great success story of a microprocessor that otherwise would have passed unnoticed. The IBM's continued patronage assured it a status of a leader. However, as soon as IBM announced a successor to its PC which runs on a more powerful 16-bit chip, the 8086, the 8088 is fading away.

Intel-8086: It is a full 16-bit version of the 8088 and more powerful than 8088. The last digit '8' in the 88 means 8 bit, the '6' in 86 means 16-bit. There is very little difficulty in moving from 8088 to 8086 for the programmers since the programs written for the 8088 & 8086 are mutually compatible. The 8086 has the same architecture, addressing modes and set of instruction as the 8088 except for the Bus Interface Unit (BIU). The 8088 BIU communicates with an 8 bit external bus, that is, it receives data in 8 bit units. The 8086 can communicate with a 16 bit external bus i.e. receive data in 16 bit units & therefore, it does not have to convert data recieved in 16-bit units to 8 bit units for processing purposes.

The internal and external functions on the 8086 permit the chip to perform tasks at the same time which other chips have to perform sequentially. For example, a Z80 chip requires an interrupt to take place before the instructions, for performing an input or output data communication function, can be executed. The input or output function on the 8086 chip can take place while the chip's internal processor is working away.

If one has a choice, one should not go for 8088 based micro, rather he should opt for 8086. One might think that microcomputers using the 8086 cost much more than 8088-based models. In fact, there is no price difference at all or the 8086 may even be cheaper.

80186: It is a 16-bit chip slightly more powerful than 8086 16-bit but most of the 8086 software is not quite fast with 80186.

80286: This is the most powerful among the 16-bit chips. It is used by IBM on its IBM-PC/AT. The introduction of more and more AT compatibles is causing wide popularity to this microprocessor.

Unfortunately, not much fresh software has yet been written for 80286 so that it is being run with the wide software written for 8088/8086. This downgrading lowers the performance of 80286 in the sense that it works at 8086 speed when used with 8086 software. Once the software, modified or specially written, for 80286 becomes available, the capabilities of 80286 would become more obvious and the chip would be appreciated and accepted by one and all.

The 80286 does have one disadvantage, it belongs to the 16-bit group of chips from Intel (8088, 8086, 80186 & 80286). Though, most chips in the group can run software written for the other chips, for example, the 80286 can run all software for 8088, 8086, & 80186, unfortunately, the other chips can't run every software written specifically for 80286. This is one factor for slow acceptance of 80286 by the users already used to 8088 and now 8086.

Upgrading RAM

Regardless of the amount of memory that comes with the computer you'll need more of it sooner or later. Maybe you can do a lot with memory already available, but you could do still more if you had more memory.

Most micros offer the option to add more of RAM later, i.e. after the system has been bought. Adding RAM is quite simple & cheap now. The larger the addition, the lesser the money spent per kilobyte.

When you add memory it is necessary to add several control circuits called memory boards or circuits in addition to the chips. These boards cost more than the chips.

Adding memory is not risky with the IBM-PC. These computers have room for some memory expansion in the basic computer. The memory expansion is just a matter of plugging in chips or a circuit card into the sockets on the computer. The sockets are already there, all you have to do is buy the memory chips separately & plug them into the sockets There is nothing to cut, solder, or modify. This way the IBM is capable of using up to 500K of memory. You can add up to 256K of memory to the IBM-PC by plugging in chips, but additional memory must be added by plugging in more expansion memory cards. It is useful to note that plugging in of memory chips does not violate the warranty

The IBM Floppy Disk

The IBM-PC disk-drive uses single-sided-double-density or double-sided-double-density diskettes, though, they are rated for quad-density. The PC-AT uses disk drive that writes data on both sides of the diskette. It uses double density diskette for its 360KB drives and quad density diskettes for its 1 2MB drives.

IMB & DOUBLE SIDED FLOPPIES

The subject of recording both sides of a floppy disk was a controversial one until recently,due to following reason

Inside the jacket surrounding the floppy disk is a special wipe material, to provide a continuous cleaning action for the disk, whenever it is in motion. When one side is being recorded or read, the rotation action is always in one direction and contaminants are collected on the inner wiping material. If that same dike is then turned over to record or read the other side, this 'other side' revolves in a direction opposite to the direction in which it had moved when it was the "up side". As a result, the contaminating material is pulled in the opposite direction by the rubbing action of the disk. This back-flushing action has a great danger of loosening & dislodging of that old debris. This debris can be redeposited on the disk's surface & also cause disk failure

IBM has solved this problem by introducing a system that permits recording on both sides of the floppy disk. The system, the IBM 3600, uses two heads, one above and one under, to engage both sides of the floppy. By using this method, IBM has avoided turning the disk over and eliminated the possibility of any damage when the disk rotates in reverse direction.

Formatting

One cannot use a floppy immediately after its purchase from the market. A new floppy has to go through a process called 'formatting' or 'initializing' before it can be used. However the IBM-PC & compatible disks are available ready formatted in the market and can be used immediately after purchase.

Soft Sector or IBM Compatible Format

The speciality of this format is that the disk has only one index hole. This solitary index hole in the disk determines the location of the first sector

The rotation speed of the floppy disk & the time it takes to arrive from the first sector to a particular sector would determine the location of that specific sector. In the soft sector format, a number of tracks, generally 77, are recorded around the disk in concentric circles beginning at the outer edge and proceeding towards the centre. The disk is further divided into generally 26 wedge like sectors.

Each of the track in the soft sector format is indentified by a double digit number beginning with 00 through 77. Track 00 at the outer edge of the disk is not used for data recording. The sectors are also assigned numbers from 01 to 26. With 76 tracks in 26 sectors for recording of data, the combination provides us with a total of 76 x 26 i.e., 1976 distinct and discreet recording areas.

Each of them is specified by the track number, say 06 and the sector number, such as 15. A zero is used to separate the track number and the sector number, so in this example 06015 represents a unique and compete "address" on the disk where information can be recorded & read till it is either erased or replaced by recording or new information. (The information or data which is recorded or stored at a specific address is called a record) It is important to note that one record is put in one sector with one, two or more tracks in length and only when all the tracks in a sector are over, the record would spill over to next sector & so on.

Soft sector disks are normally available in the market already initalized. This means that record indexes have been pre-recorded at the beginning of,and at various locations within the sectors so that when the disk is placed in use, the user can simply call the various addresses. This causes the computer or the disk-controller

in the disk-drive to move the read/write head to the address called, and it prepares the system for recording of new data or reading of data already present there. The soft sector format simply identifies the method by which prerecorded addresses are used to locate the various areas within a disk where information can be written or read.

IBM Floppy disk storage capacity

Let us examine the formation of sectors & tracks on IBM—disk i.e. the disk using MS—DOS (or PC—DOS). All MS-DOS systems use the same principal for disk layout. For a 5¼" floppy, it varies from 40 tracks and 8 or 9 sectors for double-density (whether single-or double-sided) through 80 tracks with 15 sectors on a high capacity floppy used on PC/AT. Each sector always contains 512 bytes (½ KB)

The details about the layout are as follows:

1. A regular floppy has 40 tracks The high capacity floppy (e.g. used with PC/AT) has 80 tracks.

2. There are 8, 9 or 15 sectors in a track. Generally used floppy has 9 sectors. High capacity one has 15 sectors.

3. A single sided 5¼" floppy disk thus, has 40 tracks.
   9 sectors per track
   ½ KB per sector
   i.e. *40 tracks x 9 sectors per track x ½ KB per sector*
   i.e. 40 x 9 x ½ KB = 180 KB capacity.

4. A double sided floppy has
   80 tracks (40 tracks x 2 sides)
   9 sectors per track
   ½ KB per sector
   i.e. 80 tracks x 9 sectors per track x ½ KB per sector
   i.e 80 x 9 x ½ KB = 360 KB capacity

5. MS—DOS version 1 0 recognizes only 8 sectors per track and accordingly floppy's capacity would reduce to 160 KB & 320 KB respectively for single sided and double sided.

Please note that the statement that a *5¼" double sided*, 9 sector-per-track, 40 track floppy has 360 KB capacity is not perfectly correct. In fact, not all 360 KB is available for storage of user information as some space is spent on overheads like disk directions, file allocation table, etc However, in practice, one generally mentions the full capacity of the floppy.

Table 16.1

IBM Floppy Disk Drive Features

Purpose	Storage of programs & data files
Manufacturer	Tandon Magnetics Inc.
Type	*Single-sided/double density (SSDD)* Double-sided/double density (DSDD)
Capacity	
unformatted	250K currently, potential of 500K
formatted	160K with PC-DOS
Track density (tracks per inch)	
available	48
used	40
Number of tracks	77
Sectors per track DOS 1.0	8
DOS 1.1	8
DOS 2.0	9
Bytes per sector	512
Seek time (track to track access time)	8 ms
head setting time	25 ms
Max start/stop time	500 ms
Data transfer rates	250,000 bits/second.
Rotational speed	360 rpm.

ms - miliseconds

PC/XT & Winchester Disk

The PC/XT has a Winchester hard disk of 10MB capacity. A winchester disk has the greatest disadvantage in that it is fixed, you can not remove the disk cartridge from the disk-drive and insert another one. Thus, the overall storage capacity is restricted. Once the disk is filled up, you have to copy or back-up on to seperate

floppies. This means that although the on-line storage capacity with winchester disk is much greater than with floppy disks, the flexibility is not much improved.

Since, Winchester disks can not be removed, a microcomputer with Winchester disks also often has a floppy disk system along-with the Winchester disks to allow for back-up storage. This is the case with the IBM/XT. The IBM/XT's hard disk has a capacity of 10MB. It has the cartidge drive built into the case of the machine. It also has in addition, one floppy disk drive system. Thus, IBM/XT has one hard-disk drive & one floppy-disk drive.

IBM Hard disk storage capacity

The hard disk supplied with IBM-PC/AT is a 20 MB capacity disk. Let's see how this figure comes.

1. This disk unit has two rotating disks (platters) within it. Data is recorded on both sides of each platter giving four surfaces. The surfaces are numbered as 0, 1, 2, & 3.
2. The unit has 615 cylinders.
3. Since there are four surfaces in the unit, each cylinder has 4 tracks.
4. Each track has 17 sectors per track i.e. in all 68 sectors per cylinder.
5. Each sector has capacity of ½ KB (512 bytes).

   Thus, a hard disk can store a total of 615 cylinder $\times$ 4 tracks per cylinder $\times$ 17 sectors per track $\times$ ½ KB i.e., $615 \times 4 \times 17 \times ½$ KB = 20 910 KB = 20.9 MB.

However, this figure is slightly misleading. The reason being that one whole cylinder & four sectors of each of the other cylinders are reserved and are not available for storage of user data. So a cylinder having 68 tracks (4 tracks $\times$ 17 sectors per track) actually stores data on only 64 tracks. Also out of 615 cylinders, 614 are available for storage. So effective capacity available for programs and data is reduced to 614 cylinders of 64 sectors i.e.,

$614 \times 64 \times ½$ KB = 19644 KB = 20 MB (approximately)

That's why the hard disk with IBM-PC/AT is called a 20 MB disk.

RGB Colour Monitor

IBM-PC & some other computers use a RGB colour monitor. They produce best quality colour displays. They have separate inputs for, the brightness of each element in the display (luminance) &, the colour (chrominance).

Monitor & Upgradation

The IBM-PC has two display systems. One monochrome & one colour. The monochrome display card generates excellent character text output on a video. The colour display creates very high quality colour/graphics. If the user wants both excellent text display & colour graphics he can buy both IBM monochrome & IBM colour display cards. Alternatively one can buy a single card having both features, from a different manufacturer.

IBM CPS-80 Printer

The IBM Printer is a version of the Epson MX-80 printer. This printer has an output speed of 80 characters per second.

The printer will accept forms with a minimum width of 4 inches and a maximum width of 10 inches. Paper is fed from the rear to the unit. The unit's ribbon is enclosed in a removable cartridge. Each ribbon has a print capacity of 3 million characters i.e. about 1500 pages of approximately 2000 characters each or about 10 hours work. The IBM printer uses a bidirectional, 9-wire printhead, the print head has a life expectancy of 30 million impressions. It can be easily replaced by the operator.

A 9 × 9 dot matrix pattern is used to form characters. Character sizes may range from 5 to 16.5 characters per inch (cpi), On an 8 inch line width, these pitch sizes (5, 8.25, 10 and 16 5) will produce a maximum of 40, 66, 80, and 132 characters respectively.

IBM offers two versions of the CPS-80 printer, the Matrix Printer and the Graphics Printer. The main difference between the two is that the Matrix Printer can not select the subscript, superscript, or underline print modes and can not change print modes within a line. The Graphics Printer is capable of these operations.

The IBM printer offers 3 different printing styles; normal, double, and emphasized.

Table 16·2
IBM CPS-80 Printer Features

<table>
<tr><th colspan="2">IBM CPS-80 Features</th></tr>
<tr><td>Manufacturer.</td><td>Epson America Inc.</td></tr>
<tr><td>Model</td><td>MX-80</td></tr>
<tr><td>Size.</td><td>Height: 4.2 in. 107 mm
Width: 14.7 in. 374 mm
Depth: 12 0 in. 305 mm
Weight: 12 lbs. 5.5 kg.</td></tr>
<tr><td>Printing speed</td><td>80 characters per second.</td></tr>
<tr><td>Interface:</td><td>Parallel (Centronics Standard)</td></tr>
<tr><td>Forms</td><td>Sprocket feed paper
Minimum width 4 in.
Maximum width 10 in.
Maximumthickness 3 ply: .012 in</td></tr>
<tr><td>Power·</td><td>230 V. AC, 50 Hz. 1 amp max.</td></tr>
<tr><td>Hardware features</td><td>1. 9-pin dot matrix printhead.
2. Bidirectional printing with logic seeking.
3. 9×9 dot character. 96 ASCII characters. 64 graphic characters.
4. Black ribbon cartridge (3 million character life expectancy)
5. Paper-out sensor.
6. Self-test</td></tr>
<tr><td>Software. Controlled Features</td><td>1. Print Sizes:
<table>
<tr><th>Name</th><th>Max. characters.
Pitch</th><th>Per line</th></tr>
<tr><td>Normal</td><td>10</td><td>80</td></tr>
<tr><td>Enlarged</td><td>5</td><td>40</td></tr>
<tr><td>Condensed</td><td>16.5</td><td>132</td></tr>
<tr><td>Condensed/ Enlarged</td><td>8.25</td><td>66</td></tr>
</table>
2. Print Styles· Normal, Double & Emphasized
3. Line Spacing. Adjustable to 6,8, or 10 lines per inch.
4 Horizontal and vertical tabbing.</td></tr>
</table>

IBM-PC Keyboard

Let us discuss the keyboard supplied with IBM-PC & IBM-PC/XT.

The IBM keyboard is a fun to use due to its solidity, curvature, finish, and tactile and auditory feedback.

The central part of the keyboard is similar to that of a standard QWERTY Typewriter, with some special extra keys added. The additional keys are, 10 functional keys on the left, a 13 keys numeric key-pad (including + & - keys) on the right, and a few more special keys. There are 83 total keys including 10 functional keys, 11 numeric keypad key & 55 keys in the central position.

Two colours are used, white and grey. The white keys, except for a few extra symbols, are identical to those on most typewriters. All these keys including the space bar, have auto-repeat feature, the designated character will repeat for as long as you hold down its key.

The grey keys surrounding the letter, number, and symbol keys perform a variety of functions.

The keyboard's adjustable legs allow using it in two position; tilted or level. The level position is a 5 degree angle & tilted position is the slanted 15 degree angle with the horizontal. The coiled connecting cable gives freedom to move it at will If you take the cord by both ends and stretch it out, it will be much looser and the keyboard would be easier to position

The keyboard is very simple and convenient A pencil ledge just above the top row of keys is provided to keep a pencil or pen on it. Depending upon the placement of the keyboard, one can also use it to write notes or documents Two accessories are available that take advantage of the pencil ledge, templates that display often used commands and function key definition, and plastic dust covers

Table 16 3 IBM/PC keyboard keys

No. of keys. Specification/functions

26. A to Z characters
10 0 to 9 numerals

11. –, ., [,], , (,) @, :, ~, <, >, ?

1 space bar
10. (F 1) to (F 10) function keys
11 Numeric keypad & arrow keys:

Uppercase / Lower case: 0/Ins, 1/End, 2/↓, 3/Pg Dn, 4/←, 5, 6/→, 7/Home, 8/↑, 9/Pg up, Num Lock

14 Control/special keys
I line of keyboard (Esc), (–), (scroll lock)

II „ „ (⇄), (↵), (–)

III „ „ (ctrl)

IV „ „ (⇧), (⇩), (Part SC), (+)

V „ „ (Alt), (Caps lock), (Del)

[F-4] SAVE KEY - It's followed by the name of the programme which is to be stored. This is used to store a program that is in memory into a storage device (ex. floppy-disk).

[F-5] CONT KEY - (stands for continue) This is used to restart *(continue) a program after it has been temporarily* interrupted by a STOP or CTRL BREAK.

[F-6] LPT1 FUNCTION - This function is used to transfer data from the display to the printer. When pressed in conjunction with (F-1), the program lines of the program in memory will be printed.

[F-7] TRON KEY - stands for trace on. This causes the line number of program lines to be displayed as these lines are executed.

[F-8] TROFF KEY - Stands for trace off. This is used to cancel the F-7 (TRON) function.

[F-9] KEY - Key isused to change the specific function of the other nine function keys.

[F-10] SCREEN KEY - This is used to return a program to the character mode from the graphics mode and also to turn off all colour.
'Wordstar' moves the cursor to the end of a file.

Numeric Keys (13)

[Num Lock]: This means number lock. This key is a toggle key. When the **[Num Lock]** key is pressed one time, the numeric keypad is in the numeral mode. *When the **Num Lock** key is pressed once again, the* numeric keypad is in the cursor control mode. Whenever the system is powered on, the numeric keypad is automatically set to the cursor control mode.

Numeral Mode

1 [End] through 9 [Pg Dn] While the **[Num Lock]** is in the numeral mode (status light on), keys 1 through 9 will enter numbers when they are pressed. The keys provide an alternative way to enter numerical data that is generally much faster than using the top row of the key board.

(Del) While the [Num Lock] is in the numeral mode, the Del Key will enter a decimal point.

[0 Ins] While the [Num Lock] is in the numeral mode, the Ins key will enter a 0.

(−) The minus key should only be used in the numeral mode unless otherwise indicated by a particular program.

(+) The plus keys should only be used in the numeral mode unless otherwise indicated by a particular program.

Cursor Control Keys

(↑) (←) (→) (↓) The four arrow keys move the cursor in the directions indicated by the arrows. In additions, when the cursor reaches the edge of the screen it will generally "Wrap around" continuing forward to the beginning of the next line. When the cursor reaches the bottom line of the screen, pressing the **Cursor Down** key moves the cursor down to yet one more line, which appears at the bottom of the screen. While the line previously at the top 'scrolls' off the top of the screen. When the cursor reaches the last line of the text, the **Cursor Down** key has no further effect.

Cursor Control Mode

[7 Home] While the **Num Lock** is in the cursor control mode (status light out), the Home Key moves the cursor to the first character position in the top line (top left position) of the screen. Some programs may move the cursor to the first character of the line that the cursor is currently on. One has to refer to the program user's guide of the program being used.

[8 ↑] While the **Num Lock** is in the cursor control mode, the arrow up key moves the cursor up one line every time it is pressed.

[4 ←] While the **Num Lock** is in the cursor control mode, the left arrow key moves the cursor to the left one position each time it is pressed.

[6 →]	While the **Num Lock** is in the cursor control mode, the right arrow key moves the cursor to the right one position each time it is pressed.
[2 ↓]	While the **Num Lock** is in the cursor control mode, the down arrow key moves the cursor down one line each time it is pressed.
[1 End]	While the **Num Lock** is in the cursor control mode, the End key moves the cursor to the last character of the current line of type (Bottom left position).
[*Del*]	While the **Num Lock** is in the cursor control mode, the Del key deletes the character where the cursor is positioned. If one holds the delete key down, it will keep moving to the left, deleting characters until one releases the key.
[*o* Ins]	While the **Num Lock** is in the cursor control mode, the insert key places the keyboard into the insert mode when it is pressed. It's used to insert a character. Entries are made at the current cursor position and all data to the right of the cursor position moves to the right to make room. Pressing the Insert key again switches the keyboard back into strikeover mode Anything now typed will overwrite characters already on the screen.
[Pg Up] **[Pg Dn]**	Page turners· scrolling up to show the previous screenful of data or down to the next. Some programs do not implement these two keys.

Program Control keys(7)

The following is a description of the program control keys:

[Esc] The Escape Key usually causes the computer to ignore whatever is entered on the the current line But the line is not deleted form the memory of the computer.

With some programs the Escape key is used to provide a designated function that will vary depending on the program or operating system used. One has to refer to the user's manual that comes with the program for this key's function.

[⇆] The Tab key performs functions much like a typewriter Its functions may also vary depending on the program used. One has to refer to the user's manual that comes with the program

It advances the cursor eight spaces forward or moves the cursor to the next tab position to the right, if tabs are not set

[Ctrl] This key does nothing by itself. The control key is used in conjunction with one or more other keys to perform a command or functon. These commands and functions will vary from program to program. For example, by pressing the control & the scroll-lock keys simultaneously, a scrolling screen print will stop. Refer to the user's manual that comes with the program.

[↑] The shift key is used to change lower case letters to uppercase (capitals)

[Alt] The alternate key is used with alpha typing keys to enter BASIC Keywords. It is also used in conjuction with other keys to perform various commands or functions Refer to the user's manual for the program in use

[—] The Backspace key is used to move the cursor one character to the left whenever the key is pressed. Its effect to the typing line may vary depending on the program in use.

Usually it delets the character to the left of the cursor and moves everything to the right of the deleted character one space to the left. It is also called destructive-backspace-key.

[↵] The Enter Key is used to enter the current program line from the screen into memory It is also used like a carrier return key for text processing programs. Refer to the user's manual for the program in use.

With most programs, what one types appears on the screen but is not actually entered into the computer unless one presses this key. This gives a chance to check what you have typed and make any necessary

changes in data before CPU acts on it. In word-processing program the key indicates the end of a paragraph, pressing this key returns the cursor to the left-hand side of the keyboard, down one line from its previous position.

Pressing the insert key again switches the keyboard back into strickeover mode. Anything now typed will overwrite characters already on the screen

Control key Combinations

The control key is used in conjunction with other keys to perform various fuctions in BASIC. If an application program is used, these functions may vary, so it is important to refer to user's guide for that program

The following is a description of the functions of the Control Key combinations while using BASIC. Note that the Control key is pressed down first, and is held down until the combination key has been pressed and released.

[Ctrl]+[Scroll lock]

This combination can be used to stop a program while it is running and to identify the line number where it stops.

[Ctrl]+[Num Lock]

This combination is used to stop a program while running. The program will continue when any key is presssed.

[Ctrl]+[⇆]

Combination of the control and Tab keys moves the cursor to the next word on the current line

[Ctrl]+[↑]+[⇆]

The combination of the Control, Shift and Reverse Tab keys moves the cursor to the preceeding word on the current line.

[Ctrl]+[7 Home]

The combination of the control and Home keys erases all data from the screen and moves the cursor to the upper left corner of the screen.

[Ctrl]+[Alt] +[Del]

The control and Alternate keys are pressed and held down until the Delete key is pressed. The combination of these keys cause the system to reset and reload the program or opoerating system from a diskette in drive "A" or fixed disk drive "C".

Miscellaneous Keys

The keys are outlined in gray. The following is description of the keys functions.

[Caps Lock]

Like the **[Num Lock]**, the Caps Lock is a toggle key When the Caps Lock key is pressed one time, the keyboard is locked in upper case and the letters typed will be capitals. When the Caps Lock key is pressed one more time, the keyboard is locked back into lower case When the system is powered on, the keyboard is in the lower case mode

Unlike the normal typewriter, however, pressing this does not affect the number of punctunation keys. Also unlike a typewriter, pressing **[Shift]** on the PC does not release **[Caps lock]**; instead, you 'toggle' off **[caps lock]** by pressing it a secome time. When **[caps lock]** is on, however, pressing **[shift]** generates lower-case letters.

[PrtSc]

The PrtSc (Print Screen) key enters an asterisk (*) onto the screen when the keyboard is in lower case. If the shift key is held down while the PrtSc key is pressed all data on the screen will be printed, if the printer is on.

[Scroll Lock]

The Scroll Lock/Break Key is used with the Keyboard in lower case. While the **[Crtl]** (control) key is held down, press the Scroll/Break key to interrupt a program while it is running.

[Sys]

The system **[Sys]** key will function differently depending upon the program application being used. Refer to the user's manual that comes with the program.

IBM—PC & Operating Systems

IBM offers three different disk operating systems for its IBM-PC, They are the:

1. PC-DOS
2. CP/M 86 &
3. UCSD-p-System

All of them perform similar functions but the ways in which these functions are attained are different. These differences cause each DOS to give a different personality to the IBM-PC.

We have already discussed PC-DOS and CP/M but shall reproduce PC-DOS for easy reference.

PC-DOS & MS-DOS

Tim Paterson wrote an operating system in 1980 & called it Q-DOS (Quick & Dirty Operating System!) It was written for Seatle Computer Product's S-100 system using 8086-microprocessor. Q-DOS was subsequently quite improved & by the end of 1980, it became 86-DOS.

The 86-DOS had the same interface conventions as the ones used in CP/M. Software developers by then had written a large number of application programs to run under CP/M. It was important for Seatle Computer, for marketing its 8086 interface card that the huge software written for CP/M should run on 86-DOS & then only users would be attracted towards superior features of 8086 chip.

When IBM decided to enter the micro market, it chose Microsoft for developing an operating system for IBM's personal computers. From 86-DOS, Microsoft successfully developed an operating system on a prototype IBM-PC which used Intel-8088 microprocessor. Just before the release of IBM-PC, Microsoft purchased 'exclusive' rights to 86-DOS from Seatle Computer, renamed it as MS-DOS & started selling it officially under this name. MS-DOS is now available on a variety of 8086/8088 based microcomputers. IBM was just one of the purchasers, but a giant purchaser of MS-DOS. IBM uses the MS-DOS under the name PC-DOS.

The moment IBM announced its PC, a large number of application programs were written for it creating an independent

base for MS-DOS. The MS-DOS did not have to cater or bother for large software written for CP/M & therefoe, it did not have to adopt same interface conventions as that of CP-M. Due to this reason some inherent limitations of CP/M were not to be repeated in MS-DOS. It was quite unlike 86-DOS which survived on CP/M software & had to inherit the limitations of CP/M.

MS-DOS is thus, many steps beyond CP/M. It is not irritating which CP/M users generally complain & it can handle error conditions very competently. In short, it is user-friendly.

MS/DOS resembles CP/M in someways However, in actuality, it is a version of XENIX, an operating system from Microsoft. XENIX is in turn a version of UNIX, an operating system originally developed by Western Electric.

UNIX→XENIX→MS-DOS→PC-DOS

MS-DOS and Versions

MS-DOS was released in versions of—
1.0 for IBM-PC with floppy drives & 64K memory
2.0 for IBM-PC/XT with hard disk drive
3 1 for PC jr
3 0 for IBM-PC/AT

MS/DOS version 1.0 was a very significant improvement upon CP/M However, no support was provided for hard disks, it was provided only for floppies which too will hold a maximum of only 112 files.

Version 2 0 had tree-structured filing system & was the first major move towards multitasking & multiuser systems. It could use hard disk & print-spooling.

Version 3.0 had networking capabilities. High capacity floppies were supported.

MS-DOS has several versions in circulation.

Since new versions are introduced from time to time, you may find a user with MS-DOS 2 0 version & the other with more up-to-date 3.1

The latest versions generally drive all the machines which run older versions. For instance, MS/DOS 2.1 drives IBM-PC, IBM-

PC/XT, PC jr & all the compatibles such as Compaq & the Zenith 150. Packages written for 3.1 will not be able to run under 2.0, whereas, MS-DOS 3.1 can run 'all' software written for MS-DOS till a still new version is released. The advice is to get the latest version.

If you have a micro running an old version of MS-DOS, you can buy the latest version separately, may be at extra cost (some service & maintenance contracts include upgrades free of cost), & load it on your micro without much difficulty. However, if you are going to buy a new micro, buy the one which has the latest version of MS-DOS.

The Difference Between MS-DOS & PC-DOS: IBM's PC-DOS is just another name for MS-DOS (Though there are slight differences). MS-DOS when used on the IBM-PC is called the PC-DOS or just DOS. When operated on PC-Compatibles. It is known as MS-DOS.

Some other manufacturers also call their versions of MS-DOS by different names. For example Zenith computers based on 8086/8088 chips use a variant of MS-DOS called Z-DOS.

UCSD p-System

The UCSD P-System was developed in 1970 at the University of California. It is quite different from PC-DOS & CP/M-86.

CP/M operates on five different microprocessors 8080, 8085, 8086, 8088 & Z80.

PC-DOS operates on five different microprocessors Z8000, 68000, 8080, 8086 & 8088.

The p-system operates on over 15 different mini & micro-computer chips like:

Intel	8080, 8085, 8086 & 8088
Digital Equipment	LSI-II, PDP-II
MOS Tehnology	6502.
Motorola	6800, 6809, 68000
Texas Instrument	9900
Zilog	Z80, Z8000
Western Digital Microprocessorss	Most of them

Thus, the p-system can operate on large number of computers and therefore programs written under p-system will run on much larger variety of computers than the programs written under CP/M-86 or PC-DOS.

The 'p' in p-system stands for pseudocode which in a code, produced when the programs written for p-system are compiled. The p-code is translated into machine language by what is called a p-machine emulator.

The greatest advantage of the p-system is the compatibility of the programs written under this system. A program written for the p-system for Tandy would also run under IBM-PC, Apple & any other computer which has a p-machine emulator. The p-system remains unchanged among the different microprocessors supported under the system.

UNIX

Unix was developed by US Telecommunications Company AT & T It is developed in C language.

It provides for
(i) Multiuser.
(ii) Multiterminal.
(iii) Multitasking applications.

The 32-bit machines that support multitasking and networking are generally UNIX driven The UNIX system itself supports many operations that are traditionally confined to application programs such as word processing, screen formatting, terminal-to-terminal communication, and even typesetting.

It is an excellent tool for programmers for developing programs. However, it is not user friendly. It is ideal for a user who wants to run off-the-shelf application packages. It has very complex commands which are difficult to remember & tricky to work with, even by a sophisticated user. One can make these commands more English-like but you will have to get assistance from a third party for developing a user-interface program (for example, Uniflex)

Compared to the availability a couple of years back, a large amount of software is available on UNIX However,

of the best programs developed for 16 bit operating systems for applications like word processing, can not run on UNIX.

So, one should not go for a computer using UNIX unless one really needs it for its power. UNIX may not run some most up-to-date & best programs. Also the 16 bit programs cost much higher on UNIX than on other operating systems like MS-DOS for which they were originally developed.

UNIX is good for comparatively higher bit machines, like MS-DOS is for 16 bit machines. The IBM-PC/AT uses the latest release of DOS, i.e., the version MS-DOS 3.0. This computer uses UNIX-alike structure (which IBM calls XENIX) for its multiuser mininetwork

Another recent development is that third party software developers are offering UNIX-to-MS-DOS, or XENIX-to-MS-DOS bridges. UNIX & its alikes like XENIX are the future of operating systems due to their multiuser, multiterminal & multitasking features

XENIX: (Pronounced 'Zeenix')--It's one of the versions of UNIX. It has been developed by Microsoft specially for the more advanced microcomputers.

It is a multiuser operating system, for more than five screens.

In particular, it is designed for micros using chips like the intel-8086, Z8000, M68000 etc. It has already been adopted by Altos, Tandy, Apple Lisa, Macintosh XL system, etc. However, XENIX has a great future since IBM has also adopted it on their PC-AT. Unlike UNIX, XENIX is far more geared to the 80286 high performance 16-bit chip which the PC-AT uses, than to the 16/32-bit 68000 chip.

Like the adoption of MS-DOS on IBM-PC under the name of PC-DOS has generated a breed of PC-compatibles, the adoption of UNIX on IBM-PC/AT under the name XENIX, has generated a breed of AT compatibles. All of them use versions of XENIX.

Operating System Compatibility

PC-DOS is the name under which IBM uses MS-DOS on the IBM-PC. In the main, the PC-DOS is the same as MS-DOS. But the PC, like all computers, has its own design variations.

A given micro cannot be made compatible with all the operat-

ing systems available. The microprocessor used in the micro is one of the factors which decides whether or not the micro can be made compatible with a particular operating system.

Between IBM-PC & a compatible, the most important requirement of operating system compatibility is that the compatible must run MS-DOS. That means, it must use an MS-DOS compatible microprocessor. The IBM-PC uses Intel-8088, but other 16 bit Intel-chips like 8086, 80186 & 80286 can all be used to run IBM software. These chips in fact are more powerful & offer faster performance than 8088.

Software firms continue to publish new software for machines compatible with the popular systems A computer that has a popular operating system, say MS-DOS, should run a program produced under that system However, it is a difficult criterion to satisfy In practice unless a program has been tested thoroughly on the machine in question, it should not be bought

Monitor Compatibility

Display monitors are quite well-standardized so compatibility problems are comparatively less It can be eliminated if reasonable care is taken in selecting a monitor Manufacturer's claims are generally worth trusting that a monitor will work with the computer in question.

The IBM-PC display gets its characters from a buffer memory. This memory is located at a specific address in the memory of the computer The adaptor or boards are built to output specific characters of a specific resolution The set of 256 characters used by the PC is made up of two portions. The first portion has the first 128 characters, the standard ASCII characters The second is a set of 128 IBM chosen characters. Thus, an MS-DOS computer which uses a different memory address, or does not use memory-mapped displays, or if it forms character sets at a different dot-resolution, or sends out characters different from the IBM-PC, would not be software-compatible.

Printer Compatibility

Compared to monitors, printers pose a bigger problem Printers are relatively less standardized. There are a number of ways in

which computers can address printers. The printer you buy may not be able to understand a particular way, & expect differently from a computer Enough attention and time should be devoted while selecting a printer, otherwise wrong selection may cause loss of time and money before one can effectively connect the printer and obtain desired results. Printer purchased should be of a reputed make and from a reputed dealer with a proven history of customer service

Some printers have a 'self-text' feature, the program for which is stored on computer's ROM chips. These features are used to print repeating patterns of all possible symbols, fonts, special features of the printer. However, perfect execution of such a diagnostic test is no surety that the printer is compatible. The test pattern is run in the printer, not the computer. To ensure compatibility, you should run a comparable program on the computer itself, with its output directed to the printer. Even then one cannot be sure whether the commands issued by another application program, say a word processing package, will succeed or not. True compatibility can in fact be ensured and guaranteed only by the manufacturer.

Disk Compatibility

The PC uses 5¼ inch disks formatted with 9 or 15 sectors per track and 48 tracks per inch with storage capacity of 360 K. All compatibles must offer the same disk capacity & formatting, and all must use the same size. Some non-compatible MS-DOS computers use disks of a different physical size or with a different number of tracks per inch or with different capacity or all.

Keyboard Compatibility

The placement of keys on the IBM-PC Keyboard is slightly odd Also there are keys not always found on other computer (e g. Alt, PgUp, PgDn, Numlock) To run the software written for IBM-PC on a different micro, the keyboard layout of the micro need not be the same as that of IBM-PC, slight variations may be permitted, but it can create confusion while running the software since all the manuals assume the IBM layout. At least access to all the keys has to be possible Ideally a compatible should have a keyboard layout identical to the IBM-PC.

Add-Ons (Expansion Boards) Compatibility

Most compatibles make use of large number of IBM add-ons supplied by both IBM & third parties. Some of these add-ons are fitted externally such as hard disks, network cables, etc., and to make use of them you need IBM compatible 'Centronics' port at the back of the machine

Add-ons like memory expansion boards, graphics cards, mouse card, device-controller boards, etc., can usually be added to computers that are hardware compatible. You need IBM compatible slots. Most compatibles come with about five of these, but some offer as many as eight which gives greater expandability and versatility. In the presence of component compatibility the add-ons can be freely exchanged between the paticipating machines Manufacturers of hardware components tend to design them for the most popular micro. Therefore, any micro that shares component compatibility with a famous micro might also have its versatility.

Some boards, like memory expansion boards are more amenable to transfer than others like cards dealing with display monitor capabilities.

A claim that one computer will accept boards made for another computer may not mean that the two computers are hardware-compatible; the boards just might fit in the slots but they may not be able to do what is expected of them

However, if you do find an MS-DOS computer that works alright with IBM-PC boards and vice-versa, the chances of the MS-DOS computer being software compatible are high.

IBM-PC, Compatibles & Non-Compatibles

Compatibility & particularly IBM-PC Compatibility is an important issue for microcomputer users, with many micro manufacturers widely claiming it. One gets confused by the various claims of the sellers since their claims are often tricky to interpret & it becomes even more difficult to explain as to what compatibility really means.

Let us try to discuss & answer:

1. What's IBM-PC compatibility?

2 Why is it important?
3. What is claimed by the sellers?
4 How to check PC-Compatibility?
5 Whether to go for a PC or a compatible?
6 What are non-IBM compatibles?
7 Does one really need a PC or a compatible?

IBM-PC Compatibility

We have already discussed various types of compatibilities between two micros. They all apply in case of an IBM-PC & a compatible also.

Ideally, two computers would be called "compatible" only all disk-based data files, all application programs, all peripheral and all add-ons could be traded back and forth between them Ideal compatibility is very rare or impossible

An ideal IBM-PC compatible should have the following features

1. Processor

The microprocessor used in the compatible should be intel-8088, or even if it is different, it should be capable of emulating the functions of 8088

2. Operating system

The operating system of the compatible should have features of PC-DOS Most compatible micro sellers use a similar version of MS-DOS

3. Floppy Disk

The compatible should be able to accept a 51 4" floppy disk drive in which the floppy is having the IBM format

4. Keyboard

The keyboard layout and the features of the keys should be the same as that of IBM-PC Keyboard.

5. Monitor

It should be able to display with IBM monochrome and colour display monitors

6. Printer

It should be able to print with IBM-CPS-80 printer

Why PC-Compatibility Important

Among the Microcomputers based on 8086/8088 microprocessors, maximum software is first written for the IBM-PC More than 90% PC users use MS-DOS Thus, greatest variety of software is available which can run under MS-DOS on the IBM-PC.

If your applications require a general purpose personal computer, you should have the one which runs the software written for the IBM-PC. The basic advantage in using an IBM-PC or a compatible is that the user has access to the best & the widest range of IBM software packages which are extremely reliable & useful.

With applications such as word-processing, spreadsheet, database, the case is very strong in favour of IBM or compatibles.

The Reasons for which the IBM-PC Compatibles are popular are:

(i) The similarity of hardware structure of IBM-PC which is proven for its reliability.

(ii) Transportability of data and possibility of running programs on other computers which are IBM-PC compatible

(iii) Availability of a very large number of time tested and good quality application software (Appx 25,000 or more titles by now)

IBM PC Compatibility & the Market

Personal computer suppliers often claim their micros to be 'IBM-PC' compatible: Such a claim is meaningless since 'PC compatibility' may mean anything in the micro market.

On one extreme, it may mean that a computer, when it is not running its regular operating system can run MS-DOS Every computer that merely runs MS-DOS cannot be called 'PC compatible'. Sometimes, rather than using the term 'PC compatible', the term 'MS-DOS compatibility' is used by the computer sellers

for this type of compatibility The sellers increase the confusion by using the terms 'MS-DOS compatible' or 'PC-compatible', the choice being what suits to their advantage. Some suppliers go a step beyond and call their machine 'PC compatible' when it is only 'media compatible' All these types of compatibilities whether operating system compatibility, application program compatibility, or media compatibility are very restricted types of compatibilities

On the other extreme, 'PC compatible' may mean that a computer can run all the software written for IBM-PC in wh case it should rather be called 'PC system compatible'.

The computer is least compatible if it can run only MS-DO it is the best compatible if it can run all, repeat all, IBM-P software. The latter type of compatibility is what matters and wha you should look for. Such a computer is in fact software-compatible

No micro can be 100% IBM PC compatible. Even though the version of MS-DOS, the micros use, are extremely similar to IBM's PC-DOS, they are not identical. Some sellers may claim their micros to be 100% compatible but in fact, only the IBM-PC itself can claim to be 100% compatible!

With a micro, claimed to be compatible, the variations between PC-DOS & MS-DOS may not matter in most cases, but occasions might arise when either a specific program will not run at all on MS-DOS, or certain functions within a program will not operate satisfactorily.

In practice, the machines which can run at least 95 per cent of IBM programs without bugs may be rated as IBM compatible.

Checking IBM-PC Compatibility

One should be cautious in purchasing products termed as compatible with one thing or another. It may be possible to get over minor incompatibilities which might be discovered during long use of the system but it should not create greater problems and waste your time in finding and fighting with these unforeseen incompatibilities

When you visit various computer suppliers for selecting a micro for your applications, you should not be caught upon their words and should try to understand and examine their claims

clearly. They claim compatibility of their systems with IBM-PC by showing you a list of hundreds of programs written for the IBM-PC. These programs may run without any difficulty on the computer, & yet the computer may not be IBM-PC compatible.

One of the ways of checking compatibility is to see if this list of programs includes Lotus 1-2-3 & Flight-Simulator & whether both can run on the computer under test. Lotus 1-2-3 is a good test but successful running of the Flight-Simulator program, developed by Microsoft, is the best test for confirming IBM compatibility. This is because the 'Simulator' does not use the micro's operating system but interacts directly with the hardware. Such a micro is called 'software compatible' though, a high degree of hardware compatibility is implied. The copy protection scheme for 'Flight Simulator' depends on operational features of the PC's disk drive. If those hardware features are not copied in the micro under test, it can not even load the program let alone run it Thus, the best thumb rule to ensure compatibility claim is to check the running of 'Flight Simulator' program by the micro.

IBM-PC or A Compatible

The moment you decide to buy a microcomputer the important question you will have to answer is should you opt for a IBM-PC or for one of the compatibles? The point in favour of IBM-PC is that only the real thing is 100 per cent compatible No supplier can match IBM in terms of user base, market penetration, and service and support But against those points are some very convincing arguments for opting for a compatible instead of IBM-PC:

1. Its processor is not very powerful The IBM-PC although sturdy, reliable, and popular, does not have all the latest technological advances Newer computers can be better than the PC. The chip used in the PC, Intel 8088/8086, is 8/16 bit which is slow from today's standards. More powerful chips like Intel-80186, 80286 are being used in compatible micros

2. Its disk drives are slow.
3. It is quite bulky.

4. It is expensive. The main advantage that the compatibles have over the original IBM-PC is the price. The compatibles cost up to 50% less Also most compatible manufacturers provide :.

computers with enhanced specifications to push their products in the micro market

5 IBM-PC replacement by Newer Micro: Another strong reason against opting for the IBM-PC is that there is a replacement for the IBM-PC The IBM has announced a new micro. The new machine is able to run software written for the old IBM-PC but is faster and also it does not cost more.

In terms of performance as well as price, IBM is having a tough competition with its compatible rivals. There are compatibles available which have more RAM, offer a superior level of performance & even supply the application packages for word processing, database, spreadsheet etc , free of cost

So, opting for IBM-PC is not very sensible. It is not surprising that more and more customers are getting attracted to compatibles, which perform better and are also cheaper than the PC.

Compaq Deskpro is generally considered as the best IBM compatible

The Non-IBM Compatibles

The manufacturers like Apple, Macintosh, Commodore, etc., use different microprocessors than used in IBM-PC & compatible microcomputers. Also their computers have their own operating systems & software packages. Such microcomputers are called non-compatibles However, they support the same languages with minor difference compared to the PCs.

Computers that run non-standard proprietary operating systems may be quite useful & even exceptional for some applications. But the purchasers of a non-standard machine will be limited to three software sources:

1. Computer manufacturer.
2. Independent software house.
3. User himself.

Any one who buys a computer lacking a standard operating system may find himself left out alone.

The disadvantage with non-compatibles is that they are not able to run widely available & popular IBM programs. The variety of software packages available on them is limited Their hardware

capabilities may compete with IBM but they can not use IBM peripherals & can not read/write IBM disks.

Due to the acceptance of IBM-PC as the industry standards, most of the earlier microcomputer manufacturers, who were producing micros not compatible to IBM, have changed their line of production & are now briging out IBM compatibles Very few have not changed over Among them, manufacturers like Apple have still managed to survive in the market, otherwise, most of them like Commodore, Tandy etc have shifted to IBM-compatibles Some among those, who have not changed over, have been eliminated from the micro market

As a result, the IBM compatibility has become an industry-standard based on which the micros from other computer manufacturers are judged.

Why Not Non-Compatible

The so much mention of the word PC-Compatibility might hide the fact that you may not need it. The extent to which you need it, depends on your applications For applications of word processing, spreadsheet, database etc., the compatibility is strongly required but with say accounts oriented applications, the need is less strong A computer might have unitque features or it might serve specific applications so well that you may like it even without PC compatibility

In addition, a manufacturer may have captured the market share significantly to convince the software package writers to tailor them for its machine. Thus, your choice of machines should not be limited to PC compatibles alone if the programs required by you can run better on a non-compatible machine.

Most non-compatible MS-DOS & CP/M-86 micros can not run a lot of IBM software packages The ones with a large independent base only should therefore be selected.

The IBM Success

The companies like Apple, Commodore & Tandy were the leader of microcomputer market till the entry of IBM in 1981 when it launched its personal computer, the IBM-PC.

There was nothing very extraordinary or innovative abo IBM-PC. It was like any other computer with similar capabi

used the 8088 microprocessor, the least powerful of Intel's 16-bit range The hardware also had nothing special. It is assembled from the same components bought from third parties, as is done by other mocro manufacturers. The PC did not have any innovation even in its operating system; it runs on a version of Microsoft's MS-DOS to which IBM has given it s own name, the PC-DOS.

The question then arises that even when the IBM-PC did not set any industry standards to begin with (at best it conformed to them)–Why has IBM compatibility become so important & talked about? Main factors responsible for this are

1. The Big Brother: When IBM decided to enter the micro-computer market, the industry predicted that IBM machine would become the world's best selling machine & IBM would soon become a leader in the micro market. The IBM's already existing supremacy & reputation for service, support & stability in the rest of the computer market helped it in capturing the micro market also The famous IBM brand name attached to the company & known for reliability & service was responsible for IBM-PC's smashing success, ever since its release. Thus, IBM's leadership was assured even before it actually launched its PC. Soon after the launching of the PC, people felt comfortable buying it & it was crowned with the glory of 'industry standard' all over the world The trust in the company that it would not abandon its customers, that it would provide good hardware, & above all the after-service, bestowed an added dignity to its personal computer.

2. No Secret: The IBM freely offered its system's specifications to the hardware and software manufacturers to independently develop software packages and hardware. Thus, it indirectly invited the software writers and small hardware manufacturers to come & serve the IBM-PC users. Because of this, a wide range of facilities of hardware & software was available to IBM customers.

3. Software Writers: Because of the PCs tremendous commercial success, it attracted the attention & efforts of thousand & thousands of software manufacturers, also called the 'third parties'. The software industry immediately began to develop programs on top priority for the IBM-PC.

4. Small Hardware manufacturers: An important aspect of the computer market is that you cannot sell computer hardware without software. Availability of software written for the IBM-PC

created a great opportunity for manufacturers to only produce hardware, without worrying about the software A manufacturer who can build a computer would not have to spend enormous amount on software development

The hardware industry followed the software industry by bringing products to market which were compatible with the IBM to one degree or other. Many coumputer manufacturers small as well as big ones, cashed on the IBM-PC's popularity by producing PC-compatible micros. Although, they used MS-DOS instead of PC-DOS, they virtually copied the IBM-hardware to run the programs written for PC-DOS.

The small manufacturers were able to enter the hardware *market through their products which ran the same programs as* the IBM. By offering lesser prices & enhanced specifications of their products, they drew business even from the IBM itself. For example, they used more powerful Intel-8086, 80186 & 80286 chips in the compatibles, in place of less powerful Intel-8088 chip in the IBM-PC Customers would naturally get attracted to compatibles, if they perform better & are also cheaper than the PC

5. PC-DOS: Another factor which idirectly contributed to IBM success is that most of the software written for IBM's PC-DOS, could not run very successfully on other existing MS-DOS micros

A question arises as to why the software for PC-DOS could not run on other MS-DOS micros when PC-DOS & MS-DOS are basically the same operating systems? The reasons are two fold. First, a common operating system is a necessary but not sufficient condition for hardware/software compatibility Compatibility at operating systems level does not guarantee hardware &/or software compatibility & the micro may not run majority of application programms written for PC. Second, the MS-DOS & PC-DOS do have slight differences due to which also some of the softwares written for PC-DOS, can not run on MS-DOS micros, even when they are otherwise compatible.

Despite the onslaught of compatibles, IBM is still the market leader in the world.

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Computer Software

Software for computers can be divided in two categories.

1. System software &
2. Application software

We shall be separately covering application software in detail Let us discuss about system software.

System Software: It refers to the complex computer programs written by programmers & computer experts. These programs make computers easy to use by non-experts since the complex internal functions of the computer can be achieved by use of standard English like commands. Of course, the commands are converted into machine language before the computer can perform them.

Four types of system software important for microcomputers are:

1. The Operating systems
2. Programming languages
3. Utilities
4. Communication-software.

They are the programs needed to operate the computer. Generally, they are supplied by the computer manufacturer, usually stored permanently in the memory of the computer. The computer user or the programmer generally cannot or should not change them.

The operating system programs in 2nd generation computers consisted mainly of assemblers and compilers. The third generation computers provided a variety of what are known as 'system programs'. These programs were primarily supplied to the user for efficient management of computer memory, control and supervision of input/output operations and such other jobs.

1. Operating Systems: We shall be discussing operating systems separately in great detail. They are collection of programs to facilitate efficient use of memory, disk space, CPU etc.

2. Programming Language: We shall be discussing separately in detail about them. They are the collection of English like words & phrases. Programs written in these languages like BASIC, FORTRAN, COBOL etc. are translated into machine language before *entering into a computer. The translators are available for* each language. Called as compilers, a BASIC compiler translates BASIC, a FORTRAN compiler translates FORTRAN & so on. After translation only the programs are ready for execution.

3. Utility Programs or System Utilities: A utility program is written to perform a specific but routine task. It is an efficiently written program to help the user to perform frequently used tasks by giving simple commands instead of writing a full program. These programs provide man-machine interface & greatly improve the efficiency of programming. Normally these programs are provided within the operating system. There are many utility *programs, the types of utilities used mainly depend upon the type* of computer. For example, one type of utilities permit the use of a small computer as a terminal for communicating over phone lines with larger computer. Similarly, another type of utility programs ensure that the disk-drive system, the video display, the printer, the computer memory, are all operating properly. Some utility programs even have 'diagnostic' capabilities in that they can tell which chip is malfunctioning or damaged and need to be replaced. Thus, utility programs indeed have great 'utility'. Popular examples are

EDIT — Text editor

COPY — Copying of data file from one stoiage media to another, say from hard disk to floppy disk.

SORT — For sorting data files.

We shall discuss three utility programs, the monitor, the loader & the editor.

(i) Monitor: A 'monitor' is a program that lets the user communicate with the microporcessor using the keyboard and the display. The monitor translates the physical actions of pressing the keys into numerical data for the microprocessor. The monitor also permits running of programs and examination and change of contents of RAM locations. It is normally stored in the ROM of the microcomputer.

The basic functions performed by a monitor are:

1. Permit entry: Entering/loading of data & instructions.
2. Display: Display contents of memory

3. Debugging: Change contents of memory
4. Execution: Exectute instructions & programs.

The monitor generally performs these functions in machine language.

(ii) Loader: Any user program, before it could be executed, has to be placed in the main memory of the computer. The permanent programs which are capable of reading the user programs from input devices or mass storage devices & place them into the main memory are called loaders. They literally 'load' the computer with the programs to be executed. A loader is generally stored in the ROM of the computer.

(iii) Editor: Unlike monitors & loaders, the editor is stored on an external mass-storage media. It is called into the RAM whenever the need arises.

An editor is a program which enables a user to write a program; create text; make large additions, alterations, deletions etc. in the programs & text created.

For instance, if a source program is not compiling correctly due to mistakes in it, the editor would facilitate correction. The corrected source program may be recompiled. The editor can also enable storing of final program in RAM or on an external mass storage device like a floppy disk.

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Operating Systems

An operating system tells the computer how to conduct itself. It isa set of instructions that permits the use of all the pieces of a computer, as an integrated computer system. It tells the computer how to handle its basic functioning, such as, receiving, displaying, storing, retrieving, printing etc. of the information. It tells the computer how the memory processor should divide its time between driving the printer, the disk drives, handling the data, & so on. In multiuser system the operating system controls the u· · of the system by several users at the same time such that the .sers' work doesnot clash. The operating system can also translate 'nglish like programming language like BASIC into machine !anguage through the use of special programs called Assemblers, Interpreters, Compilers.

Interface

An operating system is an interface i.e. an intermediary between the user and his computer system. It carries out the routine tasks, it understands simple commands and translates them into detailed instructions which the hardware of the computer system can understand. The operating system can, therefore, be thought of as a link between the user (through application program) and the hardware. Thus, it fills in the gap between the hardware and the application software.

A general user cannot use a computer meaningfully without an operating system. It simplifies procedures like loading of application program from disk to primary memory which otherwise can require hours of work Without an operating system the application programs themselves vould be very long, complicated and expensive.

Application Programs

An operating system is a crucial piece of software. Operating system software, different from application software like word processing etc , has a vital role in determining what one can actually do on a computer. Apart from deciding how the various

components of a computer would operate as a system, it also decides how much application software is available for a computer, what application software can actually run on the computer.

Structure

An operating system is not a single program but a collection of related programs. When a custom built operating system is being written for a computer, the writer determines what house-keeping routines will be required frequently. All of them should be included into the operating systems program. Examples of some routines are, character input and output, file management, general resource control, memory organization, etc An OS designed to run on many different computers should be able to carry out these common routines. Fortunately, most of the popular micro-computer operating systems contain a standard set of programs.

Built-in

An operating system provides the user with basic commands to use the computer & the peripherals like printer, disks, etc. I[illegible] generally supplied by the computer manufacturer & not chang by the user. However, new versions are developed regularly, o files can be used with these new versions but it is not always true

DISK OPERATION SYSTEM (DOS)

Like an operating system is a group of programs that manages the operations of a computer, a disk operating system (DOS) is a group of programs that manages the operation of a disk. The DOS manages the transfer of data to & from a disk.

The disk operating system, like application software, comes on a disk & it must be loaded into computer's memory before use. Once that is done, it can be removed, since the operating system has been stored in computer's RAM and you can now start loading the application software. In some portable computers the operating system is hard-wired in ROM and so does not need to be disk loaded.

Micro manufacturers generally use their own special Disk operating system on their computers, for example, Apple uses Apple-DOS, Radio Shack uses various version of TRS-DOS.

A computer that uses special proprietary DOS, can use programs written to run under that DOS only. This creates problems for a software developer who wants to write programs for many computers. If every computer has a different DOS, he has to completely rewrite the program for each computer.

Fortunately, the computer market being so competitive, there are several industry standard operating systems which run on many computers. However, not more than a couple of them have been accepted widely on any one type of chip.

FROM ROM TO DISK.

The smaller microcomputers have their operating systems stored in their ROMs. These operating systems need very little of ROM since they are already stored within the machine's circuitry and can be addressed at machine level.

The earlier operating systems were based on tape cassettes which were very slow and unreliable since the writing/reading of files based on cassettes were sequential rather than random. For retrieving a specific file, the computer had to go through all the previous files. Also, even for reading the operating system commands, all the data and the program files previous to the operating system had to be read until the desired location/-command was found.

This was like going through a video cassette to find say, a particular scene of a recorded cricket game. One can't jump right to the desired scene. You have to see each scene, examine whether it is the one you want and then move to the next until the desired one comes.

This technology was alright for applications & programs requiring low storage of 1 or 2K but unsuitable for large programs. These programs, in absence of sufficient storage, took very long to load and find files. For instance, wordprocessing was difficult and database management was almost impossible. Even sophisticated games could not be played with pleasure and great success.

Disk based operating systems did not have all these disadvantages. Disks can use both sequential and random access, unlike tapes which can access only sequentially. Disks offered a very powerful way for data movement between storage device

computer and also, almost immediate access to data program fi'es. On the one hand, random access facilitated file access since files could be accessed immediately after reading the disk directory which indicated where exactly a specific file was located on the disk. On the other hand, the sequential storage of files saved disk space so that more files could be accommodated in the same space

Most of the microcomputers today use Disk Operating Systems. Due to technological developments and mass production, it's now quite inexpensive also so that even smallest computers can have a DOS and a disk-drive.

Operating System Tasks

Any operating system needs to do a number of tasks. The most important ones are:

1. Monitor the instructions given by the user to the computer.
2. Load the application program.
3. Execute the application program.
4. Control the peripheral devices attached to the computer.
5. Manage the data & program files.
6. Provide utility functions that provide the user with tools for some operations like:

i) Loading programs
ii) Transferring files from one floppy to another.
iii) Formattinga disk to accept data/program.
iv) Sending information to I/O devices like printer, or a modem.

OPERATING SYSTEM AND THE USER

An operating system is a set of programs which allow optimum use of a computer by the user & the programs

The people using computers can be broadly divided in two categories, the users and the programmers.

The user wants solutions of certain problems, & for operating a computer for his needs, he wants a convenient set of commands to the computer He should be able to manage the data or programs on, say, a disk. Also he should be able to run application packages for word processing, database etc.

The programmer is an expert & his needs are of a higher nature than that of the user. Basically he needs two kinds of facilities on an operating system:

1. good tools for software development and
2. number of functions that the programs can call to use the hardware.

He needs tools that can help him in writing, putting together & debugging of programs. He needs, technically speaking, program editors, assemblers, compilers, linkers, debuggers & so on. It would be very convenient for him if the operating system can provide him some 'routines' which perform frequently needed routine tasks easily. Such tasks are file manipulation, transfer of data to & from the I/O devices & so on.

ANATOMY OF OPERATING SYSTEMS

An operating system can be thought of as consisting of three sections:

(i) BIOS or character Interpretation Section
(ii) Hardware Management Section and
(iii) Task Oriented or Utilities Section

(i) BIOS

This section also called as 'Basic Input/Output Section' has programs that permit the microprocessor to recognise the characters from the peripherals like printers, videos, etc. This section deals with all the basic input/output signals. To take an example, when a character 'P' is typed on the keyboard, the character interpretation section does three things:

(i) it tells the computer that there is some input (and not output).
(ii) that a 'P' is typed (and not 'Q' or any other character)
(iii) that the signal came from keyboard (and not from floppy disk).

This section is computer-model dependent since it relates the standard character of home language with the particular hardware components of a particular computer. An operating system is written for a particular class of microprocessor. When we select a particular microprocessor, the operating system that can be used on the computer based on this microprocessor is automatically

have utilities for opening new files, keeping files, deleting files, formatting disk, loading application programs, etc.

There is no set standard about which utilities should be included. They are available as separate packages and can be included at user's will, in the operating systems not having these utilities.

The Utilities Section permits interaction with the computer when no other application program is running. When a separate application program is loaded, the commands from Utilities Section of the Operating System are no longer valid.

Documentation of operating system

Documentation refers to papers/manuals whether printed, or typed, or cyclostyled, which describe the software package & its way of operation in details. It is very important part of the software.

Generally the documentation should include:

1. **Objective:** The purpose of the software.
2. **System Documentation:** To describe the package in details by charts, graphs, figures giving broad system specifications.
3. **Program Documentation:** Each program segment is described by giving the logic & calculations used. This helps the user-programmer, other than the original software developer to understand & if needed, modify the program as per his need. For custom-built programs, this section has full listing of source programs.
4. **User Documentation:** It has all steps & instructions for starting, running, interacting & terminating the execution of the program. It explains how the user has to give each input to the program & what output is expected out of it.
5. Control & Checks of Program: This section explains the checks provided in the software to check for the validity of input data & their controls.

Versions

The writers of operating systems keep releasing various versions of an originally developed operating system. A version is released due to following reasons:

i) There are minor & sometimes major improvements (called enhancements) in the new version over the earlier one.

limited. On the other hand, if a particular operating system is selected by a computer manufacturer, the computer dependent BIOS Section has to be customised for the particular input/output devices that the computer will use.

(ii) Hardware Management

This section contains a core of programs called 'nucleus' that manages the hardware of the complete computer system. Any action or command that the user or an application program wants to be executed, it must first be cleared from the nucleus and then only the command can be executed. The most important functions of this section are:

i) Access to Input/Output Devices — It allows or disallows the use of a particular input/output device, depending on what else is going on at that time. Like, when a printer is busy, access to it cannot be granted, and when access is finally granted to it, the nucleus transfers control to the BIOS Section and tells what should be done next.

ii) Error Messages — When illegal attempts are made the nucleus generates error messages in simple and easy to understand language.

iii) Memory Management — Assignment of memory addresses and the overall management of the memory is done in this section.

iv) Secondary Memory Directories — The nucleus maintains these directories so that the files and locations within them can be identified and retrieved.

This section is computer-model independent and hence, is not customised for every model. It is practically inviolable which means that even when the operating system is revised, nucleus programs are rarely changed, though new ones may be added. The nucleus programs are identical in every copy of the operating system. Even though, actual hardware components may differ from computer to computer, they are managed according to identical rules and procedures. The nucleus is responsible for compatibility at operating system level.

(iii) Utilities or Task-Oriented Section

This section has programs known as 'House keeping utilities.' It is through these utilities that the user can give simple commands to carry out routine tasks. For instance, an operating system may

4. It is a single user system. Digital research did develop a multiuser version MP/M but it failed due to initital bugs. Also it was slow & inefficient.

CP/M-86 & MP/M-86: Digital Research developed a 16-bit version of CP/M & MP/M when 8-bit micros started loosing popularity. These versions were called CP/M-86 & MP/M-86, respectively. They are compatible with all 16-bit chips from Intel the 8088, 8086, 80186 & even 80286. A micro using CP/M-86 may run some of the programs written for IBM-PC.

The disadvantage is that the software written for CP/M & MP/M can not be run on CP/M-86 & MP/M-86, unless it is (the CP/M) upgraded by software developers. Also the programs written for CP/M cannot run on micros using CP/M versions like CP/M 2.2, CP/M-80,CP/M +, CP/M 3.0,etc.

CP/M-86 did have some success but not as much as CP/M. Digital Research had to give way to Microsoft who developed another operating system for 16-bit micros, the MS-DOS.

With the coming of 16-bit & even 32-bit micros, micros with CP/M-cum-Z80 base are now things of past. The new micros perform much better and also the software written for them is much easy to understand & operate. The software written for CP/M was cumbersome, difficult & outdated by today's standard & hence, the micros using CP/M had no choice but to disappear.

CP/M though still considered as one of the 'industry standards', it is largely replaced by MS/DOS. It should however be mentioned that CP/M & MS-DOS behave very similarly and transition from CP/M to MS-DOS is not very difficult for programmers

Versions of CP/M

CP/M was not written for ones specific computer. There are a number of versions of CP/M for hundreds of different computers & thousands of application programs written for CP/M. Some of them are:

(i) **CP/M 80:** It is a 8-bit version, available on Zenith, DEC, Xerox, etc., & some micros manufactured by Apple & Tandy.

Conversion of application software from CP/M-80 to CP/M- is quite simple. So, large volume of software written for CP/M- [illegible] le for latest 16-bit micros running CP/M-86.

(ii) A popular operating system, like MS-DOS, may have a large number of users who discover some 'bugs' during the actual use of the system. These bugs are removed in the newer versions.

(iii) The newer version can run larger number of application software than its earlier counterpart.

The primary disadvantage with an old version is that release of a new version causes the software developers to now write for the new version. This newly developed software often would not run on the old version.

CP/M (Control Program for Microcomputers) operating system was developed during the days when storage on floppies was very expensive. Paper tape was the most popular storage device with microcomputers. So, CP/M was basically designed for handling data storage on paper tape & later converted to handle data on floppies

It was developed by Digital Research & was one of the first complete & most popular operating system in the early 80's. For the microcomputers, the leading 8-bit microprocessor of its time was Zilog's Z80 & the leading operating system to run with it was CP/M.

In fact, the CP/M had a monopoly since, no other standard was developed or survived for 8-bit micros. One reason was that big manufacturers like Apple, Tandy & Commodore continued with their proprietary operating systems (none of them CP/M), & a lot of software was available for their micro users. The rest of the market was catered by CP/M. The best advantages of CP/M was the widely available application software written for this operating system.

CP/M provided an environment, for file management, data manipulation, basic input/output operations, that was standard from machine to machine.

CP/M has a number of disadvantages:

1. Many users find its documentation difficult to understand.
2. Mastering of CP/M by first time micro user is not as easy as in case of other operating systems.
3. It presents a number of limitations while working with capacity hard disks.

4. It is a single user system. Digital research did develop a multiuser version MP/M but it failed due to initital bugs. Also it was slow & inefficient.

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Conversion of application software from CP/M-80 to CP/M-86 is quite simple. So, large volume of software written for CP/M-80 is now available for latest 16-bit micros running CP/M-86.

(ii) CP/M 2.2, CP/M-80, CP/M +

These are the versions of the CP/M operating system and were written for micros primarily using Z-80 chip & compatibles. A version of CP/M 2.2 (a version of a version!) uses 6502 chip in Apple II micro. Many computers like Commodore, Atari, etc., use CP/M versions that allow you to run a number of application programs.

(iii) CP/M 3.0: Also known as CP/M, it operates on all Z80 based machines including Heath/Zenith 89, Kaypro, Osborne, and the TRS-80 Model 4.

(iv) MP/M-86: A multiuser version of CP/M but failed to catch

MS-DOS

Tim Paterson wrote an operating system in 1980 and called it Q-DOS (Quick & Dirty Operating System!). It was written for Seatle Computer Product's S-100 system using 8086-microprocessor. Q-DOS was subsequently quite improved & by the end of 1980, it became 86-DOS

The 86-DOS had the same interface conventions as the ones used in CP/M. Software developers by then had written a large number of application programs to run under CP/M. It was important for Seatle Computer, for marketing its 8086 interface card, that the huge software written for CP/M should run on 86-DOS & then only users would be attracted towards superior features of 8086 chip.

When IBM decided to enter the micro market, it chose Microsoft for developing an operating system for IBM's personal computers. From 86-DOS, Microsoft successfully developed an operating system on a prototype IBM-PC which used Intel-8088 microprocessor. Just before the release of IBM-PC, Microsoft purchased 'exclusive' rights to 86-DOS from Seatle Computer, renamed it as MS-DOS & started selling it officiall under this name. MS-DOS is now available on a variety o[illegible] 088 based microcomputers. IBM was ju[illegible] f the pur[illegible] a giant purchaser, of MS-DOS IB[illegible] MS-D[illegible] name PC-DOS.

The moment IBM an[illegible] a l application programs were w[illegible]

base for MS-DOS. The MS-DOS did not have to cater to or bother for large software written for CP/M & therefore, it did not have to adopt same interface conventions as that of CP/M. Due to this reason some inherent limitations of CP/M were not to be repeated in MS-DOS. It was quite unlike 86-DOS which survived on CP/M software & had to inherit the limitations of CP/M.

MS-DOS is thus, many steps beyond CP/M. It is not irritating which CP/M users generally complain & it can handle error conditions very competently. In short, it is user-friendly.

MS-DOS and Versions

MS-DOS was released in versions of-
1. 0 for IBM-PC with floppy drives & 64K memory
2. 0 for IBM-PC/XT with hard disk drive
2. 1 for PC jr
3. 0 for IBM-PC/AT

MS/DOS version 1.0 was a very significant improvement upon CP/M. However, no support was provided for hard disks, it was provided only for floppies which too will hold a maximum of only 112 files.

Version 2.0 had tree-structured filing system & was the first major move towards multitasking & multiuser systems. It could use hard disk & print-spooling.

Version 3.0 had networking capabilities. High capacity floppies were supported.

MS-DOSs have several versions in circulation:
Since new versions are introduced from time to time, you may find a user with MS-DOS 2.0 version & the other with more up-to-date 3.1.

The latest versions generally drive all the machines which run older versions. For instance, MS/DOS 2.1 drives IBM-PC, IBM-PC/XT, PC jr & all the compatibles such as Compaq & the Zenith 150. Packages written for 3.2 will not be able to run under 2.0, whereas, MS-DOS 3.1 can run 'all' software written for MS-DOS till a still new version is released. The advice is to get the latest version.

If you have a micro running an old version of MS-DOS, you can buy the latest version separately, may be at extra cost (some

TABLE 18.1

The Evolution of MS—DOS

Year	DOS	Remarks
1981	MS DOS 1 0 PC DOS 1 0	First operating system on IBM-PC
	MS DOS 1 25 PC DOS 1 1	Doube sided disk support & bug fixes added Widely distributed by OEMs other than IBM
1983	MS DOS 2 0 PC DOS 2 0	Support for UNIX-alike hierarchical file structure & hard disk added
	MS DOS 2 01	2 0 with International support
	PC DOS 2 01	Introduced with PCjr, 2 0 with bug fixes
	MS DOS 2 11	2 01 with bug fixes
1984	MS DOS 3 0 PC DOS 3 0	Introduced with PC, AT, support for 1 2 MB floppy disk, larger hard disk added
1985	MS DOS 2 25	Addl support for extended character set, bug fixes
1984	MS DOS 3 1 PC DOS 3.1	Support for Microsoft Network added
1986	MS DOS 3 2 PC DOS 3 2	Enhanced support for new media types added

service & maintenance contracts include upgrades free of cost), & load it on your micro without much difficulty. However, if you are going to buy a new micro, buy the one which has the *latest version* of MS-DOS.

Difference Between MS-DOS & PC-DOS: IBM's PC-DOS is just ther name for MS-DOS (*Though there are slight differences*).

MS-DOS when used on the IBM-PC is called the PC-DOS or just DOS. When operated on PC-Compatibles, it is known as MS-DOS.

Some other manufacturers also call their versions of MS-DOS by different names For example Zenith computers based on 8086/8088 chips use a variant of MS-DOS called Z-DOS.

MS-DOS and USER

MS-DOS is a versatile operating system in the sense that it has all the features a good operating system should have. In fact,it has many more additional features One such feature is keeping track of the time of the day. It provides a variety of functions for convenient use of the hardware. It also provides a number of tools to the user to keep track of data & programs, execute programs, & design & construct new programs.

Microsoft supplies good documentation with MS-DOS. It has a Programmer's Reference Manual, User's Guide & Utility Software, with lots of tools that assist the programmer in writing applications that run under MS-DOS. It includes a macro assembler, a linker, a librarian, & cross-referencing & debugging packages.

The principal capabilities of MS-DOS are:

For the user:

(i) Management of files on the disk.

(ii) The batch feature—a sequence of commands can be stored & then excecuted in future at user's will.

(iii) Maintenance of data & time.

(iv) For input/output print spooling, pipes, filters, redirection, etc

(v) Printing of graphics display

For the advanced user or a programmer:

(i) Utility routines for handling character input/output from I/O devices like keyboard, display, printer, disk, modem, etc.

(ii) Function calls for creation/deletion of files, data-entry & access, disk access etc

(iii) Function call for time & data management.

(iv) Standard methodology for program initiation, program termination, & handling of the Break character

(v) Program development tools like assembler, linker, debugger, EDLIN etc.

Thus, MS-DOS is helpful to both users & programmers. That's why it's called *user-friendly* (The term user is used in a broad sense & includes a programmer).

The way MS-DOS *interacts* with the user is very much the same from one manufacturer's version to another. To a programmer, *MS-DOS* is user friendly & it does not take long to learn. Its commands are simple.

Once you have learnt MS-DOS on one machine, you would be familiar with 90 per cent of the commands on any other MS-DOS machine. The way MS-DOS interacts with the user, the *commands and how they are used, is very much the same from one manufacturer's* version to another.

The change from *one* MS-DOS *version* to another brings more new things to learn than change from one *MS-DOS* machine to another.

There is possibility of differences between MS-DOS package *from a manufacturer and that from Microsoft. The micro manufacturer* may add commands that are specific to some features of his hardware, and also choose not to provide some of the features that are part of the MS-DOS package from Microsoft. Also, different machines need individually tailored software; programmers bypass the operating system to produce software that is fast and easy to use

Why MS-DOS Successful: MS-DOS is a very successful operating system due to three main *reasons:*

1. *Because of the adoption of* MS-DOS under the name of *PC-DOS, for their extremely successful* IBM-PC, meant instant success for the operating system also.

2. MS-DOS is not used by IBM alone. Large number of compatibles manufacturers also use it for their systems.

3. It is being used on a range *of other products*, other than IBM compatibles, like Apricot.

Concurrent CP/M

A 16-bit operating system from Digital Research, *CP/M-86*, was a non-enhanced version. *The first* enhanced system was the ncurrent CP/M which was compatible with all software written r CP/M-86.

Concurrent DOS

The concurrent CP/M has now been replaced by concurrent-DOS which is much better & hence, appealing to the users. It works for full range of 16 bit chips from Intel. It works for single & multi-user applications, upto four video screens. It offers multi tasking & windowing. The IBM compatible & CP/M-86 programs both can be run on this operating system.

Applesoft DOS

Apple's Disk Operating System was one of the first powerful & inexpensive operating system which the user could easily handle for creation, processing & retrieval of data & program from mass storage devices. The earlier computers from Radio Shack & Commodore (PET) used tape cassettes. The availability of good storage & retrieval mechanism made Apple, the best selling computers of their time. It gave birth to an entirely new industry which devoted itself to the development of disk-based software. It created a history in the microcomputer market by selling micros like a consumer product.

Apple DOS was designed keeping a non-computer user in mind. It is a 'user-friendly' proprietary operating system allowing straight forward access to the system. On the other hand, CP/M was a professional level operating system requiring high skills for file creation & access. Apple's file management capability is so simple that even primary school children at home & school,& laymen at home,could operate a computer with pleasure.

The Apple DOS has made remarkable contribution to the microcomputer world though, it has now been largely replaced by PRODOS on Apple's IIc & IIe models. The recent Apple DOS version is 3.3 which is available on II+ & IIe computers.

TRS DOS

TRS-DOS, like CP/M & Apple DOS, is also one of the earliest operating system. It is used on TRS-80 model of Radio Shack. It is a proprietary O.S. & has a number of common features with CP/M & Apple-DOS.

One significant thing about TRS-DOS is that it distinguishes between upper & lower case letters, unlike CP/M which treats them the same. For example, if a user wants to DELETE but types Delete, the TRS-DOS will not recognize the instruction.

TRS-DOS 6.0

The latest version of TRS-DOS is TRS-DOS 6.0 (also known as L-DOS) It is more versatile & gives the user a greater access & control of files in the system

Commodore BASIC DOS

The operating systems like CP/M, MS-DOS, Apple-DOS, require the BASIC to be loaded separately like a program file. The advantage of Commodore-DOS is that both BASIC & the DOS are permanently provided in the ROM so that one doesn't have to load BASIC as a separate operation In other words it means that number of DOS commands are actually BASIC language commands which are much simple.

Commodore-DOS has another important difference. It is implemented on an IEEE bus which permits all components of the computer to behave independently. The operating system assigns a different device number to each device & all of them are linked through bus signals & operating system commands.

It is used on Commodore machines like C64, VIC 20, PET, CBM 4000 & 8000 series.

UNIX

Unix was developed by US Telecommunications company AT & T. It is developed in C language.

It provides for

(i) Multiuser
(ii) Multi terminal
(iii) Multitasking applications.

The 32-bit machines that support multitasking and net-working are generally UNIX driven. The UNIX system itself supports many operations that are traditionally confined to application programs such as wordprocessing, screen formatting, terminal-to-terminal communication, and even typesetting.

It is an excellent tool for programmers for developing programs. However, it is not user friendly. It is not ideal for a user who wants to run off-the-shelf application packages. It has very complex commands which are difficult to remember & tricky to work with, even by a sophisticated user. One can make these commands more English-like but you will have to get asistance

from a third party for developing a user-interface program (for example, Uniflex).

Compared to the availability a couple of years back, presently, a large amount of software is available on UNIX. However, some of the best programs developed for 16 bit operating systems for applications like wordprocessing, can not run on UNIX.

So, one should not go for a computer using UNIX unless one really needs it for its power. UNIX may not run some most up-to-date& best programs. Also,the 16 bit programs cost much higher on UNIX than on other operating systems like MS-DOS for which they were originally developed.

UNIX is good for comparatively higher bit machines, like MS-DOS is for 16 bit machines. The IBM-PC/AT uses the latest release of DOS, i.e., the version MS-DOS 3.0. This computer uses UNIX-alike structure (Which IBM calls XENIX) for its multiuser mininetwork.

Another recent development is that third party software developers are offering UNIX-to-MS-DOS, or XENIX-to-MS-DOS bridges. UNIX & its alikes like XENIX are the future of operating systems due to their multiuser, multiterminal & multi-tasking features.

UNIX AND VERSIONS

There are many versions of UNIX & various clones such as XENIX

XENIX (Pronounced 'Zeenix'): It isone of the versions of UNIX. It has been developed by Microsoft specially for the more advanced microcomputers.

It is a multiuser operating system, for more than five screens.

In particular, it is designed for micros using chips like the intel-8086, Z8000, M68000 etc. It has already been adopted by Altos, Tandy, Apple Lisa, Macintosh XL system, etc. However, XENIX has a great future since IBM has also adopted it on their PC-AT. Unlike UNIX, XENIX is far more geared to the 80286 high performance 16-bit chip which the PC-AT uses, than to the 16/32-bit 68000 chip.

Like the adoption of MS-DOS on IBM-PC under the name of PC-DOS has generated a breed of PC-compatibles, the adoption

of UNIX on IBM-PC/AT under the name XENIX, has generated a breed of AT compatibles. All of them use versions of XENIX.

IBM-PC Operating Systems

IBM offers three different disk operating systems for its IBM-PC. They are:

1. PC DOS
2. CP/M 86 &
3. UCSD-p-System

All of them perform similar functions but the ways in which these functions are attained are different. These differences cause each DOS to give a different personality to the IBM-PC.

PC-DOS and CP/M

We have already discussed these two operating systems in detail. MS-DOS resembles CP/M in someways. However, in actuality, it is a version of XENIX, an operating system from Microsoft. XENIX is in turn a version of UNIX, an operating system originally developed by Western Electric. In short, the equation is

UNIX→XENIX→MS-DOS→PC-DOS

UCSD p-System

The UCSD p-system. was developed in 1970 at the University of California. It is quite different from PC-DOS & CP/M-86.

CP/M operates on five different microprocessors 8080, 8085, 8086, 8088 & Z80.

PC-DOS operates on five different microprocessors Z8000, 68000, 8080, 8086, and 8088.

The P-System operates on over 15 different mini & micro-computer chips like:

Intel	8080, 8085, 8086 & 8088
Digital Equipment	LSI-II, PDP-II
Motorola	6800, 6809, 68000
Texas Instrument	9900
Zilog	Z80, Z8000
Western Digital	
Microprocessors	Most of them

Thus, the p-system can operate on large number of computers and therefore programs written under p-system will run on much larger variety of computers than the programs written under CP/M-86 or PC-DOS.

TABLE 18.2

OPERATING SYSTEMS

Operating System	Expansion	Developed By	Microprocessor	Computer	Remarks
CP/M	Control program for microcomputer	Digital Research	Zilog-Z-80 Intel-8080	8-bit micros	Old fashioned, clumsy, piecemeal
CP/M-80	CP/M version 2 2 or 3	Digital Research	8080, 8085, Z-80	Zenith, DEC, XEROX etc	first transportable O S
CP/M +	High performance of CP/M version 2.2	Digital Research	Z-80	Tandy (Radio shack)	
CP/M-86		Digital Research	Intel 8086 & 8088	16-bit micros	Less friendly than MS DOS
Concurrent CP/M-86		Digital Research	80186, 80286		Enhanced system
Concurrent DOS		Digital Research	All 16-bit chips from Intel		Multiuser, Multitasking, windowing
Z-DOS	Zenith-DOS, variation of MS-DOS	Zenith Data System		Z-100 series	Proprietary O S
PRODOS resembles MS-DOS 2 0	Professional DOS Co Ltd	Apple computer			Able to handle hard disk & floppies.UNIX, like abilities unique O S since menudriven than command driven

COMMODORE BASIC DOS				C-64, VIC-20, PET, CBM 4000 & 8000 series	BASIC permanently in ROM, IEEE BUS
MS-DOS	Microsoft disk operating system	Tim Patterson (Microsoft Inc)	Intel 8088/8086 compatible with all 16-bit chips fron Intel	16-bit IBM-PC	Single user user-friendly
PC-DOS	PC-disk operating System	Microsoft	8088, 8086	All 16-bit microcomputers including IBM-PC	
P/OS		Digital equipment Corporation	F-11	Professional	
CDOS		Cromoenco Inc	Zilog Z-80A	Cromoenco	
NEWDOS		Appart Inc	Zilog Z-80	Tandy TRS-80 Commodore, Radioshack	Distingushes lower & upper case letters
Apple-DOS		Apple Computer Co. Ltd.	6502	Apple-II	First powerful & user friendly O S
SOS		Apple computer Co Ltd.	6502B	Apple-III	
UCSD-P		Softech Micro systems	Number of processors	Number of computers	Can run on variety of microcomputers.
UNIX	Eighth version (system V)	Bell labs	Motorola 68000	Mainframes to micros	Multitasking, single or Multi-user Multi terminal
XENIX		Microsoft Inc	Intel 8086, Z8000, 68000	IBM-PC/AT	Multiuser, subset of UNIX

The 'p' in p-system stands for pseudocode which is a code produced when the programs written for P-system are compiled The p-code is translated into machine language by what is called a p-machine emulator.

The greatest advantage of the p-system is the compatibility of the programs written under this system. A program written for the p-system for Tandy would also run under IBM-PC, Apple & any other computer which has a p-machine emulator. The p-system remains unchanged among the different microprocessors supported under the system.

ENHANCED OPERATING SYSTEMS

Ordinary operating systems permit you to run only one application program at a time. However, some operating systems allow you to work with more than one program at a time. Some other operating systems allow many more features. We say that such operating systems are enhanced in their capabilities.

MULTITASKING OPERATING SYSTEMS

Multitasking describes the ability to load more than one program (task) at a time. With this facility two or more jobs can be done simultaneously. For example, one program may be printed out while working with the other on the screen. You may take a printout from a database package while typing a letter on screen with a word processing package.

Multitasking can take place at single or multiuser basis, i e., either one screen may run more than one program at a time (single user), or different screens may use different programs (Multiuser).

Multitasking has two modes, background & foreground. The fullest form of multitasking permits you to run more than one program at a time both in foreground mode.

WINDOWING

This feature permits you to 'split' the screen up in more than one part & you can see data from different programs at the same time. For instance, you may see data from your database while working on a word processing document. Maybe, certain information from database requires to be inserted into the document. You can do so after viewing the corresponding portion of database.

COMMODORE BASIC DOS				C-64, VIC-20, PET, CBM 4000 & 8000 series	BASIC permanently in ROM, IEEE BUS
MS-DOS	Microsoft disk operating system	Tim Patterson (Microsoft Inc)	Intel 8088/8086 compatible with all 16-bit chips fron Intel	*16-bit IBM-PC*	*Single user* user-friendly
PC-DOS	PC-disk operating System	Microsoft	8088, 8086	All 16-bit microcomputers including IBM-PC	
P/OS		*Digital equipment* Corporation	*F-11*	*Professional*	
CDOS		Cromoenco Inc	Zilog Z-80A	Cromoenco	
NEWDOS		*Appart Inc*	Zilog Z-80	Tandy TRS-80 Commodore, Radioshack	Distingushes lower & upper case letters
Apple-DOS		Apple Computer Co Ltd	6502	Apple-II	First powerful & user friendly O S.
SOS		Apple computer Co. Ltd	6502B	Apple-III	
UCSD-P		*Softech Micro* systems	*Number of processors*	*Number of computers*	*Can run on variety of* microcomputers
UNIX	Eighth version (system V)	Bell labs	Motorola 68000	Mainframes to micros	Multitasking, single or Multi-user, Multi terminal
XENIX		Microsoft Inc	Intel 8086, Z8000, 68000	IBM-PC/AT	Multiuser, subset of UNIX

processed document & a database file,& so on. In fact, you can see as many windows as you like & not restrict to just two. Also, information can be moved from one to the other say, database information can be moved to word-processed document. With enhanced-operating systems, these features are limited.

(5) Interactive Operation: The best of the integrated software packages are interactive. This permits you to link a word processed document to draw on information in the database, change the information, and the document will also be altered automatically. Similarly, spreadsheets can be linked interactively to databases, letters to spreadsheets, graphics to databases, and so on.

Future

Operating systems are in the process of evolution. The hardware would have more sophisticated addressing capabilities, they would provide more and more main memories on boards. The software writers would be able to allocate greater part of the operating system to housekeeping functions under the control of the user to make the systems more user-friendly.

More & more application programs would be integrated and they would be driven through the operating system's menu. The operating systems thus, would not only direct the function of the system but also monitor the access and execution of integrated application packages.

Since in practice, it is very difficult for a user to simultaneously work on two programs with a single screen, the facility of multitasking on a single micro is used for working with one program in the background & the other in the foreground. For example, printing on one program & processing on the other, so that the user is not needed simultaneously for both the jobs.

INTEGRATED PACKAGES

The integrated software packages have more than one application programs integrated into a single package. It has the advantage of allowing different types of work at the same time.

The applications most frequently integrated are; word processing, database, spreadsheet & graphics. The packages like Lotus 1-2-3, Symphony, Ashton Tate framework, Psion Xchange, Samma plus, Electric Desk, etc., integrate all or some of these applications.

Similarly, accounts packages can link together sales/purchase/normal-ledgers with stock control, payroll, other accounts programs as well as word-processing and databases. Also, these packages can easily run on MS-DOS.

INTEGRATED PACKAGES V/S ENHANCED OPERATING SYSTEMS

(1) Multitasking & windowing facilities on operating systems permit running of more than one program. Each such program is a separate package & all of them have to be loaded to the computer which is quite cumbersome. It is difficult to work with them in practice. The requirement of running of multiple programs is better met by an integrated package which intergrates more than one application into one single package. It is very easy to work with a single integrated package than with two separate ones.

(2) The intergrated packages give all the benefits of doing more than one job at the same time but they can run on ordinary operating systems.

(3) Integrated packages offer windowing as a feature of the application software rather than that of the operating system, unlike the windowing with an enhanced operating system which is the feature of the operating system.

(4) With an integrated package, you can see more than one thing at a time, say a database file & a spreadsheet, or a word-

processed document & a database file,& so on. In fact, you can see as many windows as you like & not restrict to just two. Also, information can be moved from one to the other say, database information can be moved to word-processed document. With enhanced-operating systems, these features are limited.

(5) Interactive Operation: The best of the integrated software packages are interactive. This permits you to link a word processed document to draw on information in the database, change the information, and the document will also be altered automatically. Similarly, spreadsheets can be linked interactively to databases, letters to spreadsheets, graphics to databases, and so on.

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19.
Computer Languages

The computer language is a language which a computer can understand It is the computer's 'native' language Computer languages serve the same purpose as human languages. They are a means of communication

Suppose you are a teacher of mathematics and you want to teach a student,& solve a problem for him. If you and the student both speak English, you can give your instructions in English The problem you solve for the student, with English as a medium of communication, is a specific step-by-step set of instructions 'Solution' is the term which may be used to describe the set of all steps used in solving the problem.

Like there must be a language between you and the student which both of you sould understand; the same is true between the computer and the user

Unfortunately, computers can not learn human languages like English They speak and understand their 'own' languages andit is necessary for a human to learn at least one computer language, if he wants to 'talk' to a computer

Human Vs Computer Language

A natural or human language is the language that people like you and me speak daily, like English, French, Hindi, Tamil, etc.It is made up of words and rules known as lexicon & syntax respectively. Meaningful phrases are formed by combination of words from the lexion according to the rules of the syntax They can afford to be flexible and imprecise We do notneed to say exactly what we are thinking and yet convey the meaning. People are generally tolerant about grammetical mistakes.

A computer language also consists of lexicon and syntex. i e. symbols, characters & rules of usage that permit user to communicate with computers Some languages are created to serve a special purpose (e g firing a missile) while others are more-flexible & useful for many types of applications

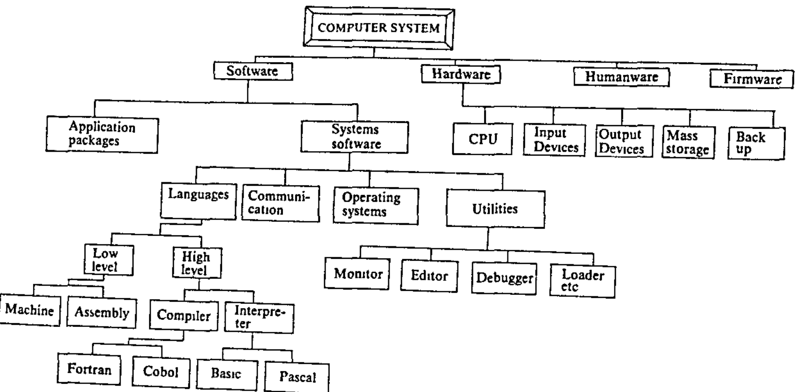


Fig 19 1 Computer System Software

However, every language has some basic written instructions that enables a computer to perform a number of operations. Fewer words but more rules are associated with them compared to natural languages 'Grammetically incorrect' formulations are altogether rejected by computers. The computer is neither a person nor does it posses intelligence and therefore it can not apply logic and distinguish between what is written & what is meant.

Computer languages can be divided in two categories. Those which are more like natural languages are called high-level, those that are more limited in lexion and syntactic flexibility are called low-level.

MACHINE LANGUAGE

The computer can understand only binary based language i.e. combinations of 0s and 1s. The language based on the binary system is known as machine language. Computers do not understand words or letters so everything must be converted to numbers before the CPU-chip can actually process the information The first Generation computers used programs which were written in machine language.

Machine language is very difficult for human beings to understand and very cumbersome to use. It is very tedious & time consuming for the programmer. Its use requires a dedicated study of the machine language used by a specific computer. It is therefore, used only by experts and experienced programmers and not by the beginners.

In a machine language, the instructions are represented by binary numbers, the sequences of 0s & 1s. It takes thousands of machine language instructions to perform even a simple job like keeping track of a list of few addresses that need to be printed on mailing labels.

Every instruction in machine language has two parts. The first part is known as the command or 'operation code', also called OP-code ,which tells the computer what functions to perform like add, multiply, move and so on Every computer has an OP-code for each of the function it can perform. The OP-codes may vary from one computer to another.

The second part of the instruction is the 'Operand' which is the address of the data that is to be operated on. It tells the

computer where to find or store the data to be processed, or where to find or store the instruction to be performed.

For example: 001010001110 represents a 12 bit machine language instruction which is divided into two parts, an operation code (OP) & an operand

OP code	Operand
001	010001110

Programming in machine language is highly technical because the programmer has to remember dozens of operation code numbers for commands in the 'machine instructions set'. He will also have to keep track of the addresses of all the data item, i.e., which storage location has which data & instruction. All this would involve a lot of time and money and yet result in errors. Tracing instructions to locate errors,or modifications,would be extremely tedious.

The number of operands in a machine language instruction varies with computer. In a single-operand computer the binary instruction 0001100001100 may probably mean "ADD 0012". This would cause the value in address 0012 to be added to the value stored in a register in the Arithmetic & logic unit (ALU).

Most microcomputers use the single operand format.

ASSEMBLY LANGUAGE

A computer language is a set of characters such as alphabets, numbers, punctuation marks or some spoecial characters. These characters are grouped together to form 'words' which may or may not be understandable to us. If a group of characters does form a meaningful word in English, then it is called a 'mnemonic'

The computer can operate only with 0s & 1s. So whatever computer language is used, the final instruction has to be in 0s & 1s.

Second Generation computers used a language called 'Assembly Language' in which symbolic codes (mnemonics) are used instead of binary numbers. The sequences of 0s & 1s of machine language are replaced by these symbolic codes. It is easier for a human to understand & remember these codes while writing a program, compared to the 0s & 1s in machine language. Though, assembly language is very easy compared to machine language, one has to still learn machine language programming in detail, before assembly language work can be done.

TABLE 19.1
Machine Code and Assembly (mnemonic) Language

Binary (Machine Code)	Octal	Hex	*Mnemonic* (Assembly)	Functions
0000	00	0	LDA	LoaD Accumulator with contents of specified address
0001	01	1	STA	STore Accumulator contents in specified address
0010	02	2	ADD	ADD contents of the specified address to the accumulator contents
0011	03	3	SUB	SUBtract contents of specified address from the accumulator contents
0100	04	4	AND	Perform an AND operation on contents of accumulator and contents of specified address placing the results in the accumulator
0101	05	5	ORA	Perform an OR operation on contents of Accumulator and contents of specified address placing the results in the accumulator
0110	06	6	JPU	JumP Unconditionally to specified address
0111	07	7	JAZ	Jump to specified address if Accumulator contents are Zero ,
1000	10	8	JAN	Jump to specified address if Accumulator contents are Not zero
1001	11	9	JAL	Jump to specified address if Accumulator contents are Less than zero
1010	11	A	JAG	Jump to specified address if Accumulator contents are Greater than zero
1011	13	B	SAI	Swap the contents of the Accumulator with the contents of the Index register
1100	14	C	ACC	Perform specified operation on the accumulator using an immediate address
1101	15	D	NOT	Perform a NOT operation on the accumulator contents
1110	16	E	HLT	Stop the program i e HaLT the processor.
1111	17	F	IOP	Perform specified Input Output operation

A program in assembly language has to be translated into machine language so that the computer can understand the instructions written in assembly language. Using a special programm called an 'Assembler', it is possible to translate an assembly language program into machine language program. An assembler takes an instruction in assembly language & translates it directly into machine code. The machine code then executes the instruction. Strictly speaking the 'assembler' actually 'disassembles' the assembly language but misnomer is accepted by all.

Each assembly language instruction may have three parts, all of which may or may not occur in a given instruction. The first part is the 'label' or 'tag'. These are the programmer defined symbols that give the address of the instruction. Then follows the 'OP code' and then the 'operand', as in the machine language instructions.

A program written in an assembly language is called a source program. An assembler program converts this source program into machine code called an object program.

To execute a program written in assembly language, two 'computer runs' are required before the source program can really produce output.

1. **Assembly-Run:** In which source program is translated by assembler program to produce object program. The source program is treated as data and is read into the CPU of the computer. During this run the problem-data (the data which really needs to be processed to solve a problem) is not processed.

Thus, the source program is not being executed. It is simply translated and stored into a form in which CPU can later execute it.

2. **Production Run:** During this run the object program is read into the CPU, input data is also read into the CPU, the data is processed and output produced. The object program.is saved for future use.

Advantages

Assembly languages have advantages over machine languages. They save time and reduce details. Lesser number of errors are made. Error is easier to detect. The programs can be easily modified.

Limitations

Coding is very time consuming, less than machine language, but still very high compared to high-level languages. They are machine oriented i.e. they are designed for specific computers. Programs have to be recoded for a different machine.

a	b	c
00111010 00000000 10000000	LDA X	
00000110 00000101	MVI B 5	LET=X + 5
10001000 00110010	ADC B	
00000000 10000000	STA X	

a. Machine code b Assembly language c. High level language

Computers can only execute machine code. The earliest computers were programmed in binary (a) The tediousness in this approach led to the development of first assembly language (b) & then high level language (c).

An instruction 'X = X + 5' has been shown in all three languages, for a particular computer.

Fig 19.2 Comparison of Machine, Assembly and High level language instruction

HIGH LEVEL LANGUAGE

It is most impractical to write programs in machine language in sequences of 0s & 1s which only the computer can understand. It isalso very difficult to remember the assembly language codes during programming.

The great need for a simple language which human beings can easily understand, & the development of mnemonic codes used in Assembly language,led to the development of high level languages such as BASIC, PASCAL, COBOL, FORTRAN etc.

Since late 1959, hundreds of 'High Level Language' (High Level for the computer, but low level for human) have been developed which use symblos and words similar to those of ordinary arithmatic and English. They are almost English-like and are independent of computer models

Hundreds of high-level computer languages, like hundreds of human languages, have been developed and are used all over the world. Many of the languages are just slight variations (dialects) of other languages. Some are extremely popular and useful.

They are often oriented towards a particular class of problems. They contain commands that are particularly well suited to one type of application. Like, a number of languages have been designed to process scientific and mathematical problems. Others emphasize file processing applications. And so on.

High level languages like BASIC contain simple commands that are translated into machine code instructions. This makes them easier to use. The commands are quite general & therefore, useful in many situations.

These High Level Languages require a compiler or an interpreter program for translating the program written in High Level Language into Machine Language which the computer can understand.

The original program written in the high-level language is called the 'source program' and its translation in machine language is called the 'object program'.

A source code consists of the program statements in original computer language, that is, the high level language.

The source code is translated by a program known as compiler which produces the compiled code which is very similar to the

machine language used by the computer. When the program is executed by the computer, it actually uses the compiled code.

COMPILERS AND INTERPRETERS

The programs written in High-level languages and Assembly language have to be translated into machine language before the computer can really execute them. 'Compilers' and 'interpreters' are translation programs that produce machine codes from high level language porograms. Assemblers are the translation programs used to translate from assembly to machine language.

The original program is called a source program and after its translation by an interpreter or compiler, it is called an object program.

They work in fundamentally different ways. A compiler takes an entire high-level languages program (source code) and produces a machine code (object code) version of it. This version is then run as a single program.

The object code is stored in the computer's memory so that, it can be used in future for executing the program. The compiler does not have to translate a source program every time it is to be executed, thus saving the execution time.

An interpreter translates the instructions of the source program into machine language one line at a time. The translated block of machine code is executed before the interpreter begins work on the next line. Thus, instructions are translated one by one and simul taneously executed, instead of waiting for the translation of the whole program to be over to execute it. No object code is stored in computer's memory for future use, the next time the instruction is to be used, it has to be freshly translated by the interpreter.

For example, during the repetitive processing of the instructions in a loop, each instruction in the loop will have to be translated every time the loop is executed.

We may say that an interpreter is a running translator. It is like a human interpreter, say for Japanese & English languages. One sentence spoken in one language by a person 'A' is translated into the other by the interpreter before 'A' proceeds to another sentence.

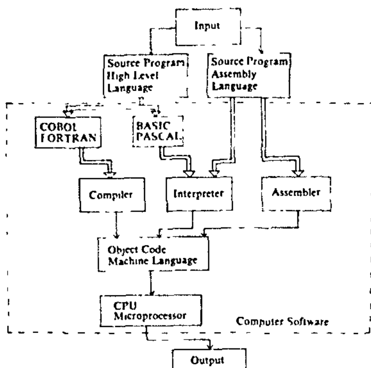


Fig 19 3—Translation & execution of source Programs

An interpreter is easier for the programmer since it permits on-line interaction with the computer i.e. the program and instructions can be corrected/altered/modified even on a running program. He can check his work & modify as he goes along. Programs are developed more easily. An interpreter is therefore preferred by people writing new software or making changes (versions) in purchased software.

On the contrary, a compiler permits off-line interaction i.e., changes are not possible in a running program. A source code has to be compiled every time a change, howsoever minor, is made in the program. This may be quite frustrating to the user & particularly to a new programmer. However, compiler is good for those needing fast execution speed.

It has become common to refer to translators, whether a compiler or an interpreter, as the languages themselves. The 'program' is often omitted from the translating someone says that FORTRAN is available for the one means is that FORTRAN translator is IBM-PC.

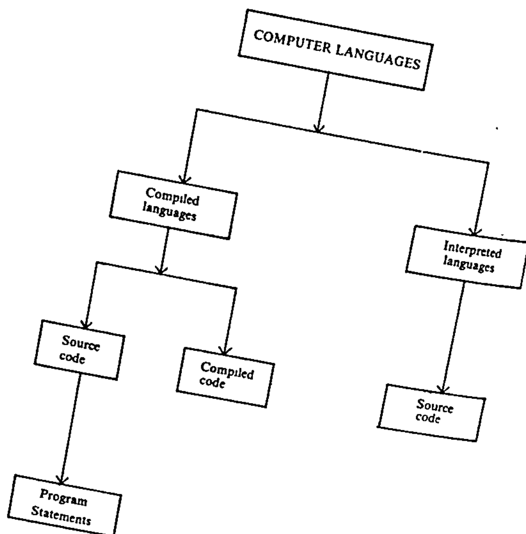


Fig. 19.4 Computer Languages

Characteristic	Assembler	Compiler	Interpreter
Ease of programming	Low	Medium	High
Ease of amendment	Low	High	Very High
Ease of learning	Low	High	High
Ease of documentation	Low	High	High
Run-time efficiency	Very high	Medium to high	Low

Personal computers often use an 'interpreter' rather than a 'compiler' for translation of high level languages into machine language.

High Level Language—Advantages

High Level Languages have the following basic advantages:

Simple to Learn

The words & phrases used in high level languages are almost-English like. The language can be easily learnt and understood after a few days study. They permit a complete beginner to learn working with the computer in a very short period of time. This family of languages, in addition to English-like words, mostly use decimal numbers in the programs written for computers.

Less Time in Programming

Being simple to learn, the programmers can write programs very fast, which is not possible with assembly or machine level languages. The programmer has to remember very simple commands which have their usual meanings like 'Stop', 'End', 'Move' etc.

The commands of high level languages are simple from the user's point of view but complex from a computer's point of view.

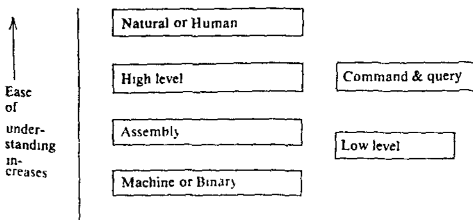


Fig 19.5 Computer Language & Ease of Understanding

For a given problem, the number of instructions in a high level language program is much lower than in assembly or machine language program For example, a single command from a high level language like BASIC might take ten lines of assembly language

Standardization

The high level languages have been standardized. Programs written in, say BASIC, can be understood by users throughout the world

Machine Independent

They are machine independent. A high level language program can be accepted by any computer which has a translator for that language.

Diagnostic Error Detection

Each high level language has its own syntax, or set of rules that govern the writing of statements (or commands) in the language. Hence, before a program is translated and executed, the compiler checks each statement in the program for syntactical errors. All such errors are outputted & translation is not begun by the computer until all errors have been corrected.

Better Documentation

Documentation means manuals, books, etc., with respect to the use of programming languages. Better documentation are available for high level languages due to wide user base than for assembly or machine languages

Easier to Maintain

Maintainability means the ease of correction or modification in a program The programs written in high level languages are more easily maintainable than the ones written in machine or assembly languages

Portable

Portability means the ease of adaption of a program on different kinds of computers. The programs written in high level

languages are more portable than those written in machine or assembly language.

Disadvantages

Slow Execution: The high level language programs are executed slowly by a computer compared to machine or assembly language programs.

A high level language called 'C' is a very good compromisation. It has high portability of high level languages and high execution speed of assembly language. Often the important packages like dBase are written in 'C' language.

Low and High Level Languages

A low-level language uses symbols which are more near to the binary-code. Assembly & machine languages are called low level. They are based on actual machine operations. The almost English-like computer languages like FORTRAN, COBOL, PL/1, BASIC etc. are called High Level Languages. They are also called 'Compilers' since they translate programs written in other languages into machine language. A low level language is also called a computer-oriented language & high level is known as problem oriented.

BASIC

The BASIC languages (Beginner's All-purpose Symbolic Instruction Code) was developed by John Kemeny & Thomas Kurtz at Dartmouth College in 1963-64. It was primarily developed keeping non-computer users in mind. It was immediately picked up for most business and general purpose applications, particularly on small computers It is more like English than FORTRAN, & easy to use. It is the most popular & widely used computer language in the world

It is an interactive language, meaning thereby that it permits direct communication between the user & the computer during the preparation & use of program. The program is compiled instruction by instruction as it is read into the computer where the computer, after editing, allows the program to be modified as it is inputted. The programmer can directly 'interact' with the computer via a keyboard terminal, quickly writing, correcting & obtaining part results of his program. Thus, 'real-time programming' is possible with BASIC. The user can 'converse' with his computer.

TABLE 19.3

Comparison of Languages

Characteristic	Low level	High level
Program development	long	relatively short
User skill required	high	much lower
Orientation	to computer	to human
Ease of modification (maintainability)	difficult	easy
Speed of execution	very high	slow
Memory requirements	minimum	high
Transferability between different computers (portability)	program confined to a particular computer	may be moved between different computers
Applications	operating systems, language processors and utilities	Application program
Diagnostic error detection	not much possible	often in-built
Documentation	not good	excellent
Representation	Binary or symbolic (mnemonic) codes	English-like words and decimal system

It is very useful for microcomputers. Here the compiler is permanently wired into the ROM of the computer, so that BASIC is in effect, a machine language. It appears as if microcomputers 'know' BASIC.

It is more easy in handling input/output data. Generally, to translate BASIC into machine language, code interpreters are used in microcomputers though, compilers are also available to translate from BASIC to machine level language.

All users with very little knowledge of computrers or programming can learn programming in BASIC in short period of time with the help of personal computer, video & keyboard.

Today, BASIC is the most popular language on micro-computers & offered by almost all computer manufacturers. Almost every personal computer available in the market is capable of understanding programs written in BASIC. It is used for greatest variety of applications from games to business to science. BASIC is even more popular than FORTRAN, COBOL, or any other language. Others are general-purpose languages which were written because someone saw deficiencies in the currently available languages.

Versions

BASIC is not a single language but it is actually a family of languages. BASIC is a generic name of a group of dialects with many similar features.

Different computers use different versions of BASIC & a program written in BASIC used on one computer may not run on a different computer. Some computers use a dialect of BASIC that is very different from the ones used on most other computers. However, a version of BASIC on one of the computers, still retains most of its usefulness, even if one moves onto another type of computer. About eighty per cent of the language stays the same from computer to computer. However, the different versions do have some real difference, although it is relatively easy to shift from one version to another.

Execution of a program written in BASIC requires an appropriate BASIC interpreter or compiler. One has to use the exact version of BASIC that the program was written for, otherwise a different version may not execute the programs correctly.

There is a minimal version of BASIC the ANSI (American National Standard Institute) standard. The standard is so simple that by now it has been incorporated in almost every version of BASIC.

The different versions are born promarily due to two reasons. One, some versions are more powerful & useful than others & two, the different versions reflect the preferences of the programmers who designed them.

For example, Atari & the Commodore 64 computers use version of BASIC that has very powerful instructions for creat of colour graphics, sounds and music by the computer.

MBASIC

It is a version of BASIC developed & used by Microsoft ('M' in BASIC stands for Microsoft) in hundreds of models of personal computers. Number of books and programs have been written on MBASIC & hence, if a micro is running MBASIC, a lot of documentation and programs would be available for it.

CBASIC:

It is a 'compiled' version of BASIC (C in CBASIC stands for compilation). It is a very good version for accounting software written for personal computers based on Z-80 chip.

Which High Level Language to Learn

Suppose your native language is Hindi & you want to learn a second human language. There are some languages like Gujrati & Marathi that are quite similar to Hindi. Others such as Sindhi are not as similar to Hindi, but do have some characteristics that are familiar to you. Still other languages like Tamil, Malayalam are so different that very few characteristics may be familiar to you. To learn Tamil, you would have to learn a completely new set of alphabets.

The above analogy can be extended to computer languages also. Some like BASIC are almost English-like though, not exactly English. There are many similarities so that one feels quite familiar with BASIC. Others like Pascal, FORTRAN, or COBOL are not so English-like but still have enough familiar terms. Still others, like Z80 have very little resemblance to English.

All computers can understand a number of languages. Most of them understand BASIC. Some can understand many languages like FORTRAN, COBOL, PL/1, PILOT, C, FORTH etc.

One should learn one of the more English-like languages before using either a machine language, or an assembly language for computer programming. When one learns BASIC, one can communicate with the computer. This is achieved by giving a program to the computer.

Of course, it is not necessary for everyone to learn programming to use a computer. A number of computer users buy the programs written by experts and do no programming themselves, but they only learn how to use these programs. The software one buys for computers & video games are really programs written by experts to tell the computers how to do a job.

The programming languages should be learnt only if some original programming is to be done. Serious business applications are difficult to write, they should be undertaken only by experts and if no suitable packages are available.

CHOOSING A LANGUAGE ON A COMPUTER

Many languages are available on microcomputers. Which language to choose depends on various factors:

1. Familiarity of user/programmer with the language: If the programmer/user already knows a language, he should prefer it over others.

2. Ease of writing: It's easier to write programs in High Level Languages than in Assembly language.

3. Nature of application: Machine languages are problem oriented whereas assembly language is computer oriented.

4. Maintainability or requirement of modification of programs: Means ease of correction or change in a program. The programs written in high level languages are more easy to correct or modify than those in Assembly languages. Thus, high level language programs are more maintainable

5. Whether support to structured programming required: COBOL, ALGOL, PL/1, PASCAL, support structured programming better than BASIC & FORTRAN.

6. Portability: Means that a program can be easily adapted for use on different kinds of computers. The software written in high-level languages is often more portable.

7. Execution speed: Assembly language programs execute at higher speed than machine language programs.

C language provides an excellent compromise between execution speed of assembly language and portability of a high-level language. That is why many newer software packages including dBase-III are written in C language.

8. Availability of translating software: A good language with an inefficient translator would not give satisfactory results.

9. Frequency of processing of application: If a job is to be run quite frequently, saving in operation time is more important than

the additional time and money one might have to invest in program preparation. A program in assembly language generally has a shorter production-run time and requires less storage space, than the one written in High level language.

10. Is a hardware change expected during the life of the application? Conversion of standardized high level language programs for new hardware is easier and faster. Computer oriented programs have to be completely rewritten.

11. Is the language supported, improved and updated by suppliers/professionals/other-users? This would make the latest versions of the program available, and at comparatively low prices.

12. Can it do the job? It is often assumed that a program written in an assembly language is better than the one written in a high level language such as BASIC. This may be true if the programs are equally well-written, but it is very difficult to judge it. You would not come across software suppliers who would call their products as 'average', they would claim that their software is the 'best'.

Also there are advantages & disadvantages to each approach in developing software. Therefore, you should not give much weightage as to how well-written a program might be while selecting one. Whether or not it can do your job is the really important criterion.

13. Documentation: Manuals are very important with respect to the use of the programming languages. Completeness, ease of understanding, cross referencing and illustrated examples are the things you have to look for.

14. Interpreter VS compiler: If the language is an interpreter, programming is simpler. But the program may be slow to execute, since the translation has to take place each time.

20

Application Programs

The biggest problem with earlier computers was the need to write a program to get anything done from them. Till recently this bottleneck was responsible for slow adoption of computers in daily life.

The recent computers have eliminated the need of expert program writers. One of the primary reasons why the personal computer is today widely used in business, office and home is a new software concept which permits processing of information without the need for the user to know a programming language.

Now there are large number of inexpensive, readymade programs for various types of applications. These programs are available in the market off-the-shelf. They permit the computer user to tailor these programs to his specific needs without demanding any knowledge of computer programming.

They are the programs written to solve particular problems. Generally they are written in a high level language like BASIC, FORTRAN, COBOL etc., by the experts who have command over the language in which programs would be written.

These readymade programs are called by various names such as 'packages of program', 'packages', 'application programs', 'application software', 'software', 'packaged programs', and so on. All these terms mean the same thing They are provided either by the computer manufacturer or by an independent software supplier. They are used for standard but widely needed applications such as pay-roll, word processing, database management, spreadsheet, accounts control, games and so on. Today, the packages like dBase, Wordstar, Visicalc, Supercalc, Multiplan, Lotus 1-2-3, Symphony, Framework, etc. have become so popular that they have become more important than the hardware.

At least 25,000 different application packages are available today with many more thousands to come.

The use of readymade programs permit the users as well as the programmers to devote their energies for more productive jobs.

TABLE 20.1

Standard application packages vs custom built software

Parameter	Standard	Custom built
Number of users	thousands	often single
Developed by	individuals, small companies	group of system analysts
Profit margin of supplier	low	high
Advantages to User		
Availability	off-the-shelf	Developed by software developers & takes time.
Programmming expertise needed	Almost nil	needed to develop & implement
Implementation time	immediate	needs study & development
Implementation skill needed	very low	often high
Dependability on hardware supplier	often nil	computer supplier has to participate
Cost	very low	high
System compatibity & transferability	General purpose, usable on systems with same operating systems	often usable on only one model of system
Need for back up	not necessary, another copy easily available	Must, loss would require complete rewriting
Disadvantages		
Adaptability	user has to adapt i.e. the business has to fit in	designed for user's exact needs
Need for documentation	excellent documentation a must	important but not crucial
Integration with existing program & data	Generally not possible	possible
Use of hardware	Not very efficient	makes most efficient use

They convert the microcomputer into a tool to increase productivity & reduce paperwork.

Types of packages

There are six common & popular types of application packages available in the market

* Word processors.
* Spreadsheets.
* Database management programs.
* Payroll and accounting programs.
* Graphics.
* Games.

Let us discuss briefly about each of them

Word Processing

'Word-processing' is the use of a computer to store, manipulate and print a text. A computer used for this purpose is called a 'Word-processor'.

What is amazing is that a computer doing word-processing can recognize a 'word', a 'sentence', or a 'paragraph' as a unit. It is very different from the typewriters which recognize only a 'Character'

Like, the word 'simple' would be treated as consisting of 6 characters i.e. six units by a typewriter: a word-processor would recognize it as one unit. It is extremely helpful in editing. For instance, if this word 'simple' is to be deleted, the Electronic-typewriter may do it in six strokes; the word-processor, just in one stroke.

The idea of word-processing is that one can type with the text into the computer, instead of onto paper. Then, errors can be corrected, text can be rearranged & all sorts of modifications can be made. It can then be seen on the screen and if you are satisfied with it, then only take a printout on paper. It is a four steps process—type, store, edit, print (STEP).

The word-processor stores the text in the memory & you can correct it later. For instance, you do not have to retype the whole 10 page report, which is stored in the memory of the word-processor when what it needs is addition or deletion of a few words. A paragraph may be added at page 4, words corrected at pages 7 & 9; & so on.

Only after the text has been corrected, revised and considered perfect, does the *processor type the final product on paper*. The product is still available in the memory. If the printed copy is not upto the mark, changes can again be made in the text in the memory and fresh copy printed. Thus, *the process can be repeated* till one is completely satisfied with contents and its get up.

Special Features

The most important advantage of the word-processors is the number of special features available on them.

The features such as centring, emboldening, half-space, decimal-alignment, block indent, right hand justification; besides, display, format, character storage memory etc., are available on word-processors.

High Speed

With a typewriter, the typist has to watch for the end of the line being typed, and press the carriage return key to start a fresh line. With a word-processor keyboard, the operator need not wait for the line to be filled up, he can simply continue typing at fast speeds, the processor would automatically start a new line when a line is filled up. He may continue typing without worrying about the mistakes, which can be corrected later. Only when a paragraph ends, it's necessary to press the carriage return key. Thus, the speed of typing is decided by the speed of pressing of keys by the operator and not by the speed of printing.

Recycling

There is no need to do retyping if you often use standard paragraphs, with minor variations, in many similar documents. Like, a contract lease in which some paragraphs may be repeated in many other leases. *You simply recall the standard paragraphs* from the memory of the processor and insert in the text wherever required.

After you have made a draft, only mistakes may be corrected to obtain a clean copy. You need not retype the whole document.

If you are sending identical letters to dozens of diferent customers, then you need only type the name and address afresh for each copy. In fact a few names and addresses can also be stored in the memory and used when requied so that even typing

of names and addresses can be avıoded. *This 'recycling' facility is* very useful.

Better Presenetation: It is much easy to produce high-quality copies from a word processor. The mistakes committed during high speed typing, can be corrected later, but before you print the text on paper. If you want to format your work elaborately, with indents, centered heading, etc. then there is no need to spend the time in planning out the format before starting to type. If you come to the end of a letter and find that there is no room for 'thanking you' and 'yours faithfully', at the bottom of the page, there is no need to worry. You can change the margin-settings or line-spacing or tab-setting & reformat the entire text and fit everything neatly on one page.,

Better Contents

The *importance of written word in business-letters, memos,* newsletters, reports, contracts, catalogues, vouchers, notices etc. cannot be overemphasized The choice of words can make difference between a sale or no sale; a negotiated settlement or a court battle; credit or no credit; clarity or confusion; communication or misunderstanding & so on.

Good writing comes from editing: going over again on what has been written, making changes to make it better both content-wise and presentation-wise. Editing leads to more acceptable and enjoyable text. This leads to better correspondence.

Small mistakes that are often accepted with ordinary typewriters due to rush of work, may be easily corrected with word processors. Afterthoughts and clarificatioı s can be added freely: A word may be replaced easily with a better word.

A well considered, well-written letter has more impact than the letter typed in a slip shod manner. In word-processing, what you write is stored as electronic impulses in the memory of the word-processor. You can edit what is 'written' and then have it printed out.

Dedicated Word-Processor: A word-processor is a computer. Sometimes people use the phrase 'dedicated-word-processor' which is a computer dedicated to only 'word-processing' and nothing else. In fact, one rarely goes for a dedicated-word-processor in practice, which does not cost less than a personal computer (or a

microcomputer). One would prefer to buy a computer which can do 'word-processing' and can do many other things in addition.

Spreadsheet

Micros can manipulate numbers very well. Using a program for spreadsheet, thousand of tedious calculations can be done & redone *automatically*.

A spreadsheet is like a sheet of paper, blank rows & columns into which figures can be entered. The intersection of each row & column is called a cell. There is a built-in calculator. It can be used for anything from shopping list to serious business application like financial projections.

A typical financial report may be set up by entering columns & rows with parameters such as sales, expenses, profits etc. Both numbers & formula may be entered. The numbers represent variables & the formula specify the relationships between the variables. If the variable values are changed, all related values, depeding upon the formula, would change. If the formula are changed, then also the related entries would be changed.

Spreadsheets are extremely useful for'what if' games. Once the model of your requirement is set, it can be used to study cause & effect relationship. For instance, what if sales decrease? or if purchases decline or if prices hike?

At home, the user can study stock exchange, income tax & so on.

Database Management

Database are warehouses of information. They can be extremely large such as a telephone directory of a cosmopolitan city like Bombay, the passenger ticket lists of Railways & Airlines or they can be short for instance, guests list of a medium sized hotel.

A database management program can easily search a particular piece of information It can sort the whole information in a particular way, for instance, a directory with names in alphabetical order may be arranged in ascending telephone numbers order & a printout obtained. The programs can also be used with other programs such as spreadsheet, *word processing, graphics* etc. The database programs also help in collection of information apart from categorizing & retrieving it in different forms.

Accounting & Payroll

Businessman can use an accounting package for payroll, accounts payable, accounts receivable, journal ledger & so on. Small businesses normally go for contract compnter services but with a microcomputer, like a PC, now they can do their own accounting & book-keeping & invest the saving & time on other more important management & administrative responsibilities.

Graphics

. These programs permit display of information as graphs or charts. Such as pie, bar, gnatt, line or other charts. The information in the form of graphs is more presentable & understandable. They are good for indentifying & studying trends.

Graphic Display & Software

Two features, colour and graphics, are very important with video display. With these capabilities, you can produce charts of many kinds, like bar, pie, etc. One can play video games. All sorts of designs and figures can be created. The features are important for all recreational, educational, business & general purposes. It makes games and learning more interesting.

Generally graphics and colours go hand-in-hand which are good for graphics application. The key to graphics capabilities is the software and the hardware both. You need hardware which caters for graphics and software which has graphics programs.

Graphics features can be added to a computer by purchase of suitable hardware at small costs. Circuit boards are available which go inside the computer. Combined with the software, sophisticated graphics can be generated by giving graphics commands to the computer.

Many computers already have required hardware but software has to be purchased separately. Writing graphics software is very complicated, so buying readymade from the market is advisable. It helps the user who can't write his own programs in BASIC or machine language.

The software for graphics can be divided in three categories.

(i) **Predesigned:** This class of software consists of pictures and designs on a disk or cassette which can be loaded to your computer and you get on the screen what is there on the disk. Not much useful since you can not develop your own graphics.

(ii) Games: The second class is the famous graphics created during video games. Graphic-aid-programs are available for creating your own graphics. A number of computer companies sell such software. However, the colour graphics generated by this class of software is very poor though the computer hardware may be capable of generating excellent colour graphics.

(iii) Business Graphics: The last is the most versatile class. You can create all kinds of graphs, bar, pie, gnatt & so on. Headings, footings, labels and data etc. can all be put together and various sizes of graphics is possible.

The application packages which are best from graphics point of view are the ones which integrate wordprocessing with spreadsheet and database. The best ones are Lotus 1-2-3, Symphony, Ashton Tate, Framework, Psion Xchange etc. They permit automatic creation of various types of charts and graphs from the data entered by user in database. The packages work interactively in the sense that when the user changes the data, the charts and graphs adjust and reappear automatically.

Games & Recreation

The most popular application of personal computer at home is games. Although the use may decline with the advent of inexpensive, easy-to-use software for other purposes and the computer networks, games will continue to be one of the most popular application.

Games are not only fun & relaxation but they are educational too. The child (or adult!) can sharpen his skills of problem solving & eye-hand coordination and develop abilities to react creatively, solve problems logically, and make decisions. Games are often the best learn-to-programs challenges for the beginner, yet the professional programmer may even find himself defeated in attempting to write complex game programs (for example, chess). Games encourage imaginative and constructive programming and responses

There are a number of games available in the market, some are good, some are bad. They can be divided into at least eight major categories that have been adapted to the computer:

1. Fantasy and adventure games.
2. Video games: They emphasize action & graphics & often require a colour graphic board.

3. Strategy and battle games.
4. Card games.
5. Board and word games.
6. Gambling games.
7. Sports games.
8 Party games.

Integrated Package of Programs

The packages spreadsheets, wordprocessing, graphics, etc. discussed so for are stand-alone packages i.e. they are useful for only one type of application. Sometimes it is useful to incorporate spreadsheet data in a report produced with word processing, or to produce graphics presentations directly from data base files.

Such requirements have caused the development of packages that integrate data from different stand-alone packages. Such software is capable of producing a very useful product that is also easy to understand. The integrated software packages have more than one useful application programs which can interact intimately with each other, integrated into a single package. It has the advantage of allowing different types of work at the same time. These programs are sold as a group & not separately.

Accounts packages can link together sales/purchase/ normal-leadgers with stock control, payroll, other accounts programs as well as word processing and database. A package of the Home Accounts, Ultra File, and the Tax advantage can be used to maintain personal finance records. This 'triple' program is useful for preparation of data comparison of budgets and completion of tax forms etc.

Interaction of Programs

Two programs are said to 'interact' when the output from one program can be used as the input for other program. In many applications, two or more programs have to 'interact' with each other to perform a job.

For example, a spreadsheet program might be used to compare financial consequences of many different policies. And this data may be used for generation of reports etc. by a word processing program. Two programs which can interact in this sense are said to be compatible.

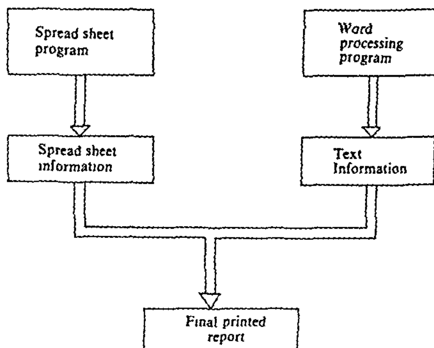


Fig 20.1 COMBINING PACKAGES (Integrated packages)

There is a lot of demand for programs which can interact. Packages are available which have two or more interacting programs, for example, packages consisting of programs; database & graphics, and so on.

The applications most frequently integrated are: word processing, database, spreadsheet & graphics. The packages like Lotu' 1-2-3, Symphony, Ashton Tate, Framework, Psion Xchange, Samma Plus, Electric Desk, etc. integrate all or some of these applications.

Lotus 1-2-3 is an excellent integrated package of spreadsheet, database management and word-processing.

VisiCalc

It is the first spreadsheet application program of its time. When business micors had just entered into the market, it was one of the few programs available on micros for professional applications. The VisiCalc indeed brought a computer revolution in business fields. It was the first readymade practical & mass-produced program available to business professionals. It created a market for PCs.

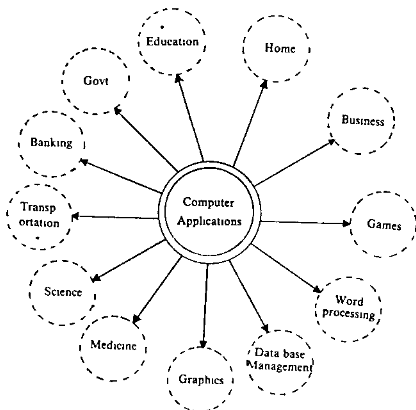


Fig 20 2

VisiCalc produces a spreadsheet on the video screen which can be used by professionals like management thinker, simply by putting a series of easy-to-enter arithmetical & logical formulae.

Wordstar

WORDSTAR is a word-processing program having the following capabilities.

Capabilities of Wordstar

1. On-Screen Formatting

Wordstar will display a piece of text on the Screen the way it will look when printed out. One can see actual line-breaks, page-breaks, paragraphs, centring, top, side and bottom margins etc. and change them if one wants before printout.

2. Word Wrap

When a word runs over the end of a line, Wordstar automatically moves the whole word down to the next line. You do not have to push carriage return at the end of each line. Functionally it:

A Suitable Micro for Wordprocessing

Sinclair spectrum—Poor
Sinclair spectrum plus—Bad
Oric Atmos—fair
Commodore Vic 20—poor
Atari 800 XL—good
Acorn Electron—Bad
Commodore 64—good
Amstard CPC 464—poor
Commodore plus/4—poor
Sinclair QL—good
Acorn BBC—very good
Apple IIe—very good
IBM-PC—Perfect
IBM-PC/AT—Perfect

Framework

This package was released by Ashton Tale in 1984. It has the following packages into one integrated package
Wordprocessing
Database management
Spreadsheet
Graphics &
Communications.

The components (modules) appear as three dimensional frames on the computer screen & any or all of the above jobs can be performed by the user.

Symphony

This is a latest version of Lotus 1-2-3. Introduced in 1984, this incorporates all the features of 1-2-3 in addition to many more. It's available on large number of computers such as IBM-PC/XT, IBM-PC/AT, Desk Pro, Compaq portable etc It includes:

Spreadsheet
Database
Wordprocessor
Graphics
Communication &
Microprogramming.

The first three are the 1-2-3 features. In fact,even the Lotu: features have been much improved in symphony. For instance, number of features are additional to spreadsheet. Windows allow display of one or more operations. simultaneously on the monitor screen.

Having a size of 256 columns x 8192 rows, it is quite sophisticated The commands may appear slightly complicated to a beginner but little experience would make them easily understandable. The minimum RAM memory requirement for all features to be operative is 320K.

One other important feature of symphony is that even other programs can be run in its environment. This facilitates data transfer & exchange very efficient

The commands have been streamlined compared to 1-2-3. True automation is indeed feasible now even with a small computer, with the help of symphony.

It is a very powerful package with large number of features & capabilities. Even very ambitious professionals find this tool up to their expectations. The Lotus 1-2-3 itself is very powerful but symphony is a much more powerful extension over 1-2-3 & the commands under both are almost same. It would not be difficult 1-2-3 user to shift to symphony.

Soft Pro 4-5-6

It is new powerful and easy to use package having spreadsheet, graphics & database management capability. It has all the positive features of Lotus 1-2-3 but a lot easier to work with compared to 1-2-3 With the run-time facility of Soft Pro 4-5-6, one does not need to know the spreadsheet commands to run applications developed on 4-5-6 Multiple application templates can be developed & loaded as DOS files.

TABLE 20.2

Some Application Software for IBM-PC

Home

(i) Games/Entertainment

1. Backgammon	Flight simulator
2. Bridge Tutor	Zork I
3. Computer Math Drills	Decathlon ,
4. Poker Drill	Loderunner
5. Spelling Bee	Flight simulator
6 War Games	

(ii) Home Management

1 Cheque book Balancing	Home Budget
2 Income Taxes	Personal Investor
3 Mortagage Analysis	Home Accounts Plus
4 Magzine file	Tycoon
5 Birthdays	Millionaire
6 Appointment Planner	
7. Mailing Lists	
8 Time Management	
9 Menu Planner	
10 Letter Writer	
11 Message Board	
12 Spell Writer	
13 Energy Efficiency Analysis	

(iii) Education

1 Interactive Typing Tutor	
2 Memory Management	Monster Math
3 Magic Spelling	Typing Tutor
4 Reading Levels	Trutle power
5 Using Adjectives Adverbs	
6 Addition and Subraction	
7 Division Drills	
8 Calculus	
9 Statistics	
10 Geography Lessons	

(iv) Finance

1 Stock Trends
2. Stock Portfolio Management
3 Commodity Trading
4 Investment Analysis
5 Options Analysis

(i) Word processing	Wordstar,Easy Writer
(ii) Spreadsheet	VisiCalc,Multiplan,Lotus 1-2-3.
(iii) Database Management	dBASE III,Lotus 1-2-3
(iv) Graphics	Louts 1-2-3

Database programs are the most useful personal computer programs. The Table names a number of the thousand of types of information that may be stored, indexed, organized, or cross-referenced by database programs

Table 20.3

Uses for Database Management System.

BUSINESS USES	EDUCATIONAL USES	HOME & HOBBY USES
Customer filing	Student records	Personal records
Prospect lists	Grade records	Check lists
Master files for	Teacher lists	Club rosters
Gen Ledger	School lists	Telephone directories
Accts Receiv	Program design	Recipes files
Accts Payable	Tuition data	Medical information
Payroll Records	Enrollment data	Property records
Personal data	Property/equipment	Appliance warranties
Telephone logs	Athletic schedules	Insurance records
Telephone lists	Player assignment	Christmas lists/gifts
Hotel/travel data	Games schedules	Appointments
Reservations	Player statistics	Articles indexes
Property control	Mailing lists	Tax records/data
Library catalouges	Test scores	Expenses
Inventory	Menus	Book ownership
Key Employee data	Diet selections	Utility records
Advertising data	Inventory	Deposit files
Source files	Seating charts	Due dates
Sales leads	Cataloguing	Travel records
Mail lists	Laboratory data	Meal planning
Private records	Inspection data	Mortgage data
Corp records	Experimental data	Auto records
Directories	Attendance data	Crop yields
Billing information	Course description	Source files
Delivery schedules	Purchase orders	Magazine Article index
Routes	Requisitions	Estimate files
Territories	Vacation records	Investments
Quotations	Budgets	Plus all the Business &
Appointments	Maintenance data	Educational overlaps
Conventions	Locker assignment	
Workshop data	Field trips	

Assets lists	Vehicle records
Marketing data	Tenure records
Insurance data	Parking assignment
Pricing schedules	Violation records
Formulas	Meeting schedules
Production data	Facility schedules
Processes	
Cross referencing	
Commission records	
General filing	

TABLE 20.4

Some examples of Computer applications in different fields.

Accounting

1 Accounts Receivable
2 Business Check Register
3. General Ledger Package
4 Business Bookkeeping System
5. Depreciation Planner
6 CAP Client Write-Up

Agriculture

1. Cattle Feeding Economics
2 Farm Management
3 Crop Costing, Yield per acre.
4 Fertilizer Formulation
5 Sheep Production
6. Corn Production
7 Soil Erosion
8 Livestock management
9 Crop mix & rotation

Business Management Tools

1 General Business Program
2 Business Planner
3 Personal Report System
4 Financial Planner
5 Salary Planner
6 Electronic Spreadsheet
7. Accounting Tutor
8 Income Meets Expense
9. Job Costing
10 Sales Analysis
11. Home Construction

Table 20.5

Some action games on famous Computers.

Game	Manufacturer	Computer
Atic Atac	Ultimate	Spectrum
Blue Max	Data Soft	Atari
Boogaboo (the Flea)	Quicksilva	Amstrad, Spectrum
Boulder Dash	First Star	Atari
Bruce Lee	Data Soft	Atari, spectrum
Gridrunner	Llamasoft	Atari
Jumpman	Epyx	Atari
Loderunner	Broderbund	Apple, Atari IBM PC, Spectrum
Manic Miner	Software Projects	Amstrad, BBC Spectrum
Missile Command	Atari	Atari
One on One	Electronic Arts	Aple, Atari
Pssst!	Ultimate	Spectrum
Pengo	Atari	Atari
Pinball Contruction	Electronics Arts	Apple, Atari
Pole Position	Atari/Data Soft	Atari, BBC Spectrum
Rescue on Fractalus	Lucasfilm	Atari
Robotron 2084	Atari	Atari, BBC
Shamus	Synapse	Apple, Atari
Splat!	Incentive	Spectrum
Star Raiders	Atari	Atari
Way Out	Sirius	Apple, Atari
Zaxxon	Data Soft	Atari, Spectrum
3D Ant Attack	Quicksilva	Spectrum

Table 20.6

Some thinking and management games on famous Computers.

Game	Manufacture	Computer
Airline	CCS	BBC, Spectrum
Archon	Electronic Arts	Apple, Atari
Boardroom	Wessexsoft	Spectrum
Comanex	Sapphire Systems	CP/M
Company Director	Molimerx	Tandy
Corplan	*Understanding Ltd*	Apple, BBC, Tandy
Dallas	CSS	BBC, Spectrum
Dictator	dk'Tronics	Amstrad, BBC, Spectrum
Eastern Front, 1941	Atari	Atari
Flexi-game	Ulster Management Centre	BBC
Football Manager	Addictive	Amstrad, BBC, Spectrum
Great Britain Ltd	Simon Hessell	Spectrum

Millionaire	Blue Chip	Apple, Atari, IBM-PC, Macintosh
MULE	Electronic Arts	Apple, Atari
Scrabble	Leisure Genius	Apple, BBC, Spectrum
Seven Cities of Gold	Electronic Arts	Apple, Atari
Stockmarket	Argus	Atari, Spectrum
Stockmarket	Amsoft (Amstrad), Micro-Aid (BBC), Kuma (CBM64), Spectrum (CSS)	
Tycoon	Bule Chip	IBM PC
Woodstock	Hama	BBC
1984	Incentive	BBC, Spectrum

Table 20.7

Some flight simulators on famous computers

Game	Manufacturer	Computer
Airbus	Molimerx	Tandy
Air-Sim-1	Mind Systems	Apple
Airbus	Molimerx	Tandy
Aviator	Acornsoft	BBC
Cleared for landing	Programmers Software	Apple
Concorde	Molimerx	Tandy
DC-10	Molimerx	BBC, Tandy
Dragonfly	Hewson	Dragon
Flight Path 737	Anirog	Vic-20
Flight Simulator	Psion	Spectrum
Flight Simulator	Amsoft	Amstrad
Flight Simulator II	sub Logic	Apple, Atari
Fly One	Kuma	Sharp
Jumbo jet Pilot	Thorn EMI	Atari
Nightflite	Hewson	Spectrum
Pilot	Hewson	Sinclair ZX-81
Solo Flight	Microprose	Atari.
Spitfire Simulator	Mind Sytems	Apple
TR80-FS1, A2-FSI	sub Logic	Apple, Tandy
737 Flight Simulator	Salamander	BBC
747 Flight Simulator	dacc	Atari, BBC, Dragon Tandy, Spectrum
747 Flight Simulator	Doctor Soft	BBC
Dambusters	US Gold	Amstrad, Spectrum
F-15 Strike Eagle	Microprose	Atari
Fighter Pilot	Digital Integration	Spectrum
Interdictor Pilot	Supersoft	Amstrad.
Spitfire Ace	Microprose	Atari.
Strike Attack	Micro Mart Software	Spectrum
Wing Commander	Creative Sparks	Atari

21
Compatibility

The small computers market is about 2 decades old. During the early days the models from different manufacturers were totally incompatible. They used different microprocessors, different operating systems, different software programs. The operating systems were often proprietary and software was often written specially for a manufacturer for one or few of his models. Even the different models from a manufacturer could have different operating systems and software.

It was very difficult for a general user to cope with such incompatibilities. He had to depend on a particular model, a particular operating system, restricted software and a particular supplier.

Standardization: The then leaders of micro market, Apple, Commodore and Tandy had their own operating systems for their microprocessors. Writing an operating system for one microprocessor is very costly but these companies could afford this approach due to lack of competition in the micro market that time. They could enhance the cost of hardware to compensate the investment on the software. The hardware & software both were costly for a general user.

Fortunately this stage did not continue for long. As more and more hardware and software manufacturers joined the industry, the hardware prices came down and it was no longer feasible to get new standards developed for each and every machine.

There came an era of off-the-shelf, microprocessors, operating systems & application software. The microprocessor manufacturers started supplying to almost all the hardware manufacturers, the operating systems were mostly common and the application programs could run on most of the industry standard microcomputers. This made computerization extremely cheap, the micros became easily accessible to one and all.

By now, industry standards have been established and accepted almost all over the world. This has immediately benefited not only the users but also the programmers, the hardware and

software manufacturers, in fact, to one and all as we shall shortly see.

Most of the present micros, though they may be having different names on the outside, are basically same from the inside. They run on same chips, same operating systems, same application software. In short, they are 'Compatible'.

BENEFITS OF COMPATIBILITY

A compatible is advantageous to both, the computer user and the manufacturer.

Hardware Manufacturer and User: The peripherals are mass produced for the most popular computers and their compatibles. It is advantageous to new manufacturers, since it permits them to enter into the market and ensures customers.

To the users, the tough competition keeps the prices in line and also a variety, even among the compatibles, becomes available.

Software Manufacturer and User: The programmers can write program for many different models at the same time. One version of a program can meet needs of thousands of users of different computers. Programmers can concentrate their talents on improvements of old versions and creation of new types of programs with surety of market.

The tough competition keeps the software prices unbelievably low for the users who would otherwise have to spent thousands and lakhs of rupee for custom built programs.

Hardware and Software Manufacturers: Even small manufacturers have joined the micro market for manufacturing hardware which can run the already existing software. They do not need to hire programmers to write programs for their machines. Earlier it was not possible and lot of finances had to go in just getting the programs written. But now, even small companies can produce machines of their ideas. The result is a still greater variety for the user.

Thus, compatibility is a boon for all, the hardware manufacturer, the software writer & the user.

TYPES OF COMPATIBILITIES

The Major types of compatibilities we shall discuss are:

1. Operating System Compatibility.
2. Application Program Compatibility.

(i) Application Programs and computers.
(ii) Application programs that interact.
(iii) Media or data compatibility.

3. Hardware Compatibility.
(i) Component Compatibility
(ii) Complete Computer system compatibility.

To run an application program on a micro, one has to first load the micro with an operating system and then with the application program. In some cases, an application program will run successfully on any machine that can run the right operating system. The statement that two computers are compatible at operating system level means that they can both run the same operating system.

In some cases, an application program will not run on different computers even if they are compatible at operating system level. A particular hardware configuration is additionally needed. Two computers are compatible at application programs level if they can run the same application program. Please note that the compatibility at operating system level is automatically implied.

Finally, two computers may be compatible with each other in all respects. They can run the same operating systems & the same application programs. They can even drive the same peripherals. Many of the circuit boards containing chips can even be traded back and forth. Two computers having these properties are called to be compatible at system level. Two computers compatible at system level can exchange virtually all software, hardware, peripherals and expansion options between them.

1. Operating System Compatibility:

An operating system is a collection of computer programs that tell the computer how to peform certain routine tasks. With an operating system these routine tasks become faster, easier &, more obvious.

Number of tasks are performed routinely in various application programs. For example, signals have to be sent from keyboard to the processor to display characters on the monitor, or disk drives may be asked to perform a task, and so on.

For an operating system to be run on a particular computer, the operating system has to be 'brought' on that machine. What it means is that the programs making up the operating systems are

customised by the manufacturer of the machine. The instructions for speific hardware components like disk drives, keyboards, monitor, etc. are generally 'burned' into the ROM of the computer. The manufacturer will repeat this chip in every computer. Less important routine tasks may be supplied separately on a disk.

Computers that can run a particular operating system are said to be compatible with that operating system. They will understand the same operating system commands. The computers may be very different from the inside but if they can run the same operating system, they would look the same to the operating system.

The operating system compatibility is very useful to a programmer. While writing an application program 'inside' (we shall just explain what it means) an operating system, he does not need to write computer specific instructions to tell the computer what and how to perform. Rather, he can use the operating system as a shortcut & use simple commands. The operating system can interpret & convert them into detailed instructions & then pass them on to the processor. Any computer compatible with the operating system will understand these instructions.

If all the tools a programmer needs for writing a program are available in the operating system, & if he does not use any special features of a particular computer, he is said to be writing 'inside' the operating system. Such a program will run perfectly well on any computer compatible with that operating system. However, if he cannot find everything he needs within the operating system & uses some special features of a particular computer, he has written 'outside' the operating system & such program may not run well on other computers compatible with the operating system & we say that the operating system compatibility is lost in this case.

Standard Operating Systems

Some common operating systems for micros are the CP/M, MS/DOS, Apple System, etc. CP/M is available in various versions. Two important ones are CP/M & CP/M-86 The others like CP/M, Concurrent CP/M, etc., are more powerful than CP/M but there is nothing special about them as far as compatibility is concerned. Each is an operating system & if it isoffered on a particular computer, the software written 'inside' can be run on that computer.

PC-DOS is the name under which IBM uses MS-DOS on the IBM-PC. In the main, the PC-DOS is the same as MS-DOS but the PC, like all computers, has its own design variations.

The most important form of compatibility is software compatibility, where software written for the IBM-PC will run without any flaw on other MS-DOS computers.

Between IBM-PC & a compatible, the most important requirement of operating system compatibilty is that the compatible must run MS-DOS. That means, it must use an MS-DOS compatible microprocessor. The IBM/PC uses Intel-8088, but other 16 bit Intel-chips like 8086, 80186 & 80286 can all be used to run IBM software. These chips in fact are more powerful & offer faster performance than 8088.

Software firms continue to publish new software for *machines* compatible with the popular systems. A computer that has a popular operating system, say MS-DOS, can run any program ever produced under that system, provided the programmer stayed inside it. However, it is difficult criterion to satisfy. In practice, unless a program has been tested thoroughly on the machine in question, it should not be bought.

Non-Standard Operating Systems

A given micro can not be made compatible with all the operating systems available. The microprocessor used in the micro is one of the factors which decides whether or not the micro can be made compatible with a particular operating system.

Computers that run non-standard proprietary operating systems may be quite useful & even exceptional for some applications. But the purchasers of a non-standard machine will be limited to three software sources:

1. Computer manufacturer.
2. Independent software house.
3. User himself.

Any one who buys a computer lacking a standard operating system may find himself left out alone.

Compatibility and Modified Operating Systems

There is a secondary type of operating system compatibility that sometimes is useful. Some computers can only run modified

versions of popular operating systems because their hardware resources prevent the computers from using the full-fledged versions of the operating system. For example, some machines may not have drives, and have comparatively small memory reserves. A modified operating system could compensate for this.

2. Application Program Compatibility

Application Programs involve three kinds of compatibilities:

(i) That between computers that can run the same application programs as well as the operating system; also called software compatibility.

(ii) Internal compatibility between application programs that interact with each other.

(iii) Media or data compatibility.

We shall discuss each one of them in detail.

(i) Application Program and Computers

It frequently happens that a programmer is forced to violate the operating system compatibility due to various reasons. One, because operating systems are quite restrictive & two, the temptation on the part of the programmer to use the computer's special features which it might offer (such programming may be called hardware dependent programming). The programmer may desire to create special visual effects, or want to increase the speed of programme execution, or want to achieve other extraordinary features. For example, the characters displayed on a computer screen may be changed more quickly by addressing the hardware directly than by going through the operating system. Thus, when updating of the screens is desired to be fast, the programmer will have to write a machine-specific program. This violation would give rise to error, if the program is run on a wrong machine.

If two computers can run exactly the same & all application software available on any one of them, they are said to be compatible at the application program level. These computers will automatically be compatible at operating system leve also. Thus, application programs compatibility is a very strong type of compatibility & implies a strong similarity between the computers. It is normally claimed by micro sellers but is often not found in practice.

(ii) Compatibility Between Programs that Interact

Two programs are said to 'interact' when the output from one program can be used as the input for other program. In many applications, two or more programs have to 'interact' with each other to perform a job.

For example, a spreadsheet program might be used to compare financial consequences of many different policies. And this data may be used for generation of reports etc. by a word processing program. Two programs which can interact in this sense are said to be compatible.

Integrated software packages are designed to combine many useful programs which can interact intimately with each other. These programs are sold as a group and not separately.

There is a lot of demand for programs which can interact. Packages are available which have two or more interacting programs, for example, packages consisting of word-processor, spelling checker and mass mailing programs, database & graphics, and so on. A package of the Home Accountant, Ultra File, and the Tax Advantage can be used to maintain personal finance records. This 'triple' program is useful for preparation of data, comparison of budgets and completion of tax forms etc. Lotus 1-2-3 is an *excellent integrated package of spreadsheet, database* management and word-processing.

(iii) Media or Data Compatibility

One may like to transfer data from one computer to another of a different design. If the computers are comptible at operating system level, there would be no difficulty in making the transfer.

Even if they are not compatible at operating system level, a lesser degree of compatibility, called the media or data compatibility, can ensure that the computers can read disks written by other computers & write disks that can be read by other computers. Media compatibility thus enables two computers of different disign to share data on disks.

Media compatibility is achieved between computers that use similar disk drive systems, or in other words, employ the same disk 'formats'.

It is not automatic, & therefore, it can not be assumed even in presence of the same operating systems and disk types. Further,

care is taken in selecting a monitor. Manufacturer's claims are generally worth trusting that a monitor will work with the computer in question.

The IBM-PC display gets its characters from a buffer memory. This memory is located at a specific address in the memory of the computer. The adaptor boards are built to output specific characters of a specific resolution. The set of 256 characters used by the PC is made up of two portions. The first portion has the first 128 characters, the standard ASCII characters. The second is a set of 128 IBM chosen characters. Thus, an MS-DOS computer which uses a different memory address, or does not use memory-mapped displays, or if it forms character sets at a different dot-resolution, or sends out character different from the IBM-PC, it would not be software-compatible.

Printer Compatibility

Compared to monitors printers, pose a bigger problem. Printers are relatively less standardized. There are a number of ways in which computers can address printers. The printer you buy may not be able to understand a particular way, & expect differently from a computer. Enough attention and time should be devoted while selecting a printer otherwise,wrong selection may cause loss of time and money, before one can effectively connect the printer and obtain desired results. Printer purchased should be of a reputed make and from a reputed dealer with a proven history of customer service.

Some printers have a 'self-test' feature, the program for which is stored on computer's ROM chips. These features are used to print repeating patterns of all possible symbols, fonts, special features of the printer. However, perfect execution of such a diagnostic test is no surety that the printer is compatible. The test pattern is run in the printer, not the computer. To ensure compatibility, you should run a comparable program on the computer itself, with its output directed to the printer. Even then one cannot be sure whether the commands issued by another application program, say a word-processing package, will succeed or not. True compatibility can in fact be ensured and guaranteed only by the manufacturer.

Disk Compatibility

The PC uses 5¼ inch disks formatted with 9 or 15 sectors per track and 48 tracks per inch with storage capacity of 360 K. All

compatibles must offer the same disk capacity & formatting, and all must use the same size. Some noncompatible MS-DOS computers use disks of a different physical size, or with a different number of tracks per inch, or with different capacity, or all.

Keyboard Compatibility

The placement of keys on the IBM-PC keyboard is slightly odd. Also there are keys not always found on other computers (e.g. Alt, PgUp, PgDn, Numlock). To run the software written for IBM-PC on a different micro, the keyboard layout of the micro need not be the same as that of IBM-PC, slight variations may be permitted, but it can create confusion while running the software since all the manuals assume the IBM layout. At least access to all the keys has to be possible. Ideally, a compatible should have a keyboard layout identical to the IBM-PC.

Add-Ons (Expansion Boards) Compatibility

Most compatibles make use of large number of IBM add-ons supplied by both IBM & third parties. Some of these add-ons are fitted externally such as hard disks, network cables, etc., and to make use of them you need IBM compatible 'Centronics' port at the back of the machine.

Add-ons like memory expansion boards, graphics cards, mouse card, device-controller boards, etc., can usually be added to computers that are hardware compatible. You need IBM compatible slots. Most compatibles come with about five of these, but some offer as many as eight which gives greater expandability and versatility. In the presence of component compatibility the add-ons can be freely exchanged between the participating machines. Manufacturers of hardware components tend to design them for the most popular micro. Therefore, any micro that shares component compatibility with a famous micro might also have its versatility.

Some boards, like memory expansion boards, are more amenable to transfer than others like, cards dealing with display monitor capabilities.

A claim that one computer will accept boards made for another computer may not mean that the two computers are hardware-compatible; the boards just might fit in the slots but y may not be able to do what is expected of them.

However, if you do find an MS-DOS computer that works alright with IBM-PC boards and vice-versa, the chances of the MS-DOS computer being software compatible are high.

(ii) Complete System Compatibility

System compatibility is the highest, most powerful and ideal compatibility. One computer manufacturer may provide system compatibility between two of his computer models, one small and the other large, to make both of them versatile. In the micro market, various manufacturers may provide system compatibility on different computers of same sizes, generally to copy a famous brand.

It is extremely difficult to ensure system compatibility since it is practically impossible to test a computer under all possible alternatives of software, hardware, peripherals and expansion boards. Even in cases where testing has been done with the alternatives presently available and the computer runs successfully, problems may crop up later, say when a newly purchased software is run. The best approach to overcome this risk is to buy a computer which has withstood the test of time and has created a large number of users.

System compatibility is difficult to achieve in practice, not because it is technically difficult but, because it creates legal problems. A famous computer's internal control systems are generally proprietary to the manufacturer who designed them. For example, the ROM chip is designed to customize an operating system for a particular computer. It can not be copied by other manufacturers and if they do so, they may have to face legal suits for infringing the proprietary rights. Here comes in the 'intelligence' of the manufacturers in that how they duplicate the functions, without copying the ROM!

Even in cases where all ROM functions are retained, another difficulty may arise. The ROM functions may be stored in different memory locations by different manufacturers. If an application program is run on a different machine, it would not find what it expected when it reaches the memory location.

22
Selecting a Computer

Selecting a computer is slightly complicated. Innumerable models with highly differing characteristics & with huge price differences are available in the market. Buying a TV is not difficult since it is a single function device. A computer on the other hand is a multi-function device. It can calculate, can educate, can entertain, can keep records & so on. Of course, not all computers can perform all jobs equally well.

1. Identify Applications

The first thing *in selecting a micro is to identify your requirements.* You should have a clear idea as to what exactly you want the computer to do for you. Many people buy computers either because they develop fancy to one, or it is a fashion to have a computer, or that they would buy first & find the use later, & so on.

Most prospective buyers want to buy a computer for one or two major applications. In case you have more than one requirement, they should be listed in order of priority. For example, you should examine whether your primary requirement is word-processing, or games & entertainment, or graphics, or education. If your top-priority is graphics & you have already bought a micro which cannot display graphics properly, it is an unwise investment.

For instance, a typical manufacturer company may like to have a computer for doing the following jobs in decreasing order of priority:

1. invoicing & sales record (customer files)
2. maintaining books of accounts
3. maintenance & control of inventory
4. maintenance & control of product items
5. follow-up with debtors
6. word-processing
7. spreadsheet
8. payroll etc.

For most users, there would be some or the other secondary applications for buying a micro. It is interesting to know that after

media compatibility applies to data only, not programs. The data might be stored in text files or numerical files. Most complex programs written on foreign disks will not execute properly unless media compatibility is supplemented by higher degree of compatibility such as compatibility at the operating system level or at the application program level, as the case may be.

Sometimes, even when the computers are not data compatible, software sellers may help in transferring files between the computers. A translation software may be available for use when operating systems are different or if the disks have different storage capacity.

Xenocopy for the IBM-PC can read files from & can write files to disks of different formats. Xenocopy incidently is very specific to the IBM hardware. It is one of the very few software that will not run on any PC compatibles.

Sometimes the computer manufacturer will supply software that allows you to read files prepared on other machines.

3. Hardware Compatibility

The computer hardware brings two kinds of compatibilities·

(i) Peripherals and add-ons compatibility—also called component compatibilitiy, viz-a-viz a particular computer.

(ii) Complete computer system compatibility.

(i) Component Compatibility

A peripheral device is said to be compatible with a given computer if it can be connected to that computer system and can work successfully.

Sometimes a little modification may be required for the peripheral to run alright. When it is so, clear and detailed instructions should be available about the modification needed. In practice, they are frequently not. So, ensuring a guarantee from the supplier for problem-free operation is advisable.

The component compatibility is dependent upon the degree of standardization. Among the popular peripherals like monitors, printers, etc., the degree of compatibility goes down as the amount of design standardization goes down.

Dispalay Compatibility

Dispay monitors are quite well-standardized so compatibility problems are comparatively less. It can be eliminated if

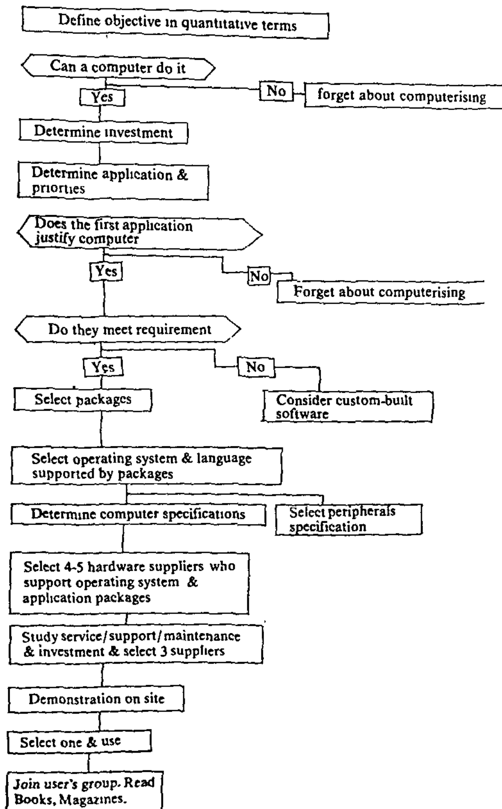


Fig. 22.1–Selecting a Computer

a micro has been bought, these secondary applications may take more of computer time than primary ones.

Consultant

At the time of studying your applications requirements, you may take advice from a micro seller. Many sellers have computer specialists who can study your requirements & volume of work, & suggest you a good system.

Also there is now abundance of independent consultants in the computer market. That is because the number of computer systems and the number of users is growing exponentially. Some systems and applications are quite complicated. They cannot be understood and adopted without the assistance of professional advisers.

In case you must engage a consultant, the question arises— How much you should pay him? They either charge lumpsum or a percentage of the overall system cost. For the micros, they would normally charge lumpsum. In fact, the prices of micros are dropping constantly over last few years due to which, the consultants fee now is a large proportion of the overall cost of the micro.

2. Software Requirements

A computer can work only if it has a program to follow. Without a program, it is like a car without petrol The program or software makes the computer to do what you want it to do. There are two sources for the application programs. One, readymade from the market, written by the experts & second, you can write your own programs. Most micro users get them from the market.

For a new buyer, it would be difficult to know what all software is available or may be available for his applications. A visit to few computer shops & to other computer users who have computerized their applications would be worth it. You can ask them to demonstrate the packages & then you can judge their suitability to your own applications

If you want to write your own programs, then you must examine the languages available on the computer you are thinking of buying. BASIC, the most popular language is available on most micros, other languages like PILOT, 'C', 'FORTH', Pascal, are also available on few micros.

Software has to be evaluated on the following points:

1. Compatibility
2. hardware requirement
3. other users experience
4. genuineness
5. manuals/documentation
6. support
7. price.

We shall mention genuineness & compatibility in brief. The rest of the points have been described at other places in the book. Kindly go through them.

Compatibility

If you are buying an IBM-PC, thousands of application programs have been written for it. Many other computer manufacturers are producing micros & claiming them to be IBM-PC compatible. One should not be misled by ads however, you should test the compatibility by actually running few IBM-PC programs.

An important criterion for selecting a micro should be whether it can run a variety of application software which is available in the market & can meet your applications.

Genuineness

The genuineness of the software should be definitely enquired. Many times the software offered 'free of cost' in the price of the micro is 'pirated'. It is an offence to possess such illegal copies. Also, this pirated software may be incomplete & not guaranteed. It is not supported in the sense, you cannot officially get the latest versions which are often released by the original software manufacturer. These versions are sometimes vast improvement over the earlier ones Missing this opportunity may mean a great loss to you in terms of time & money. Finally, buying pirated software is immoral. One is indirectly putting away good programmers from the market who had developed the software anticipating that the user would pay the right amount for it.

3. Hardware Requirement

The next step is to assess your need for hardware depending upon your processing requirements.

The exact requirements for sizes & qualities of different devices like memory, keyboard, printer, display etc. should be worked out after studying applications in detail. Also, you should keep an upward margin of at least 50% for future expansion & unforeseen emergencies.

(i) Size of RAM

Requirements of homes, education, entertainment, personal accounting, etc., may be satisfied by a 8-bit micro having 64K RAM. The requirements of a small business are met by a 16 bit micro having 256K RAM. However, some specialised application packages need larger memory. For such applications, a micro with proper RAM size or with upgrading facility should only be selected. For further details please go through the chapter on RAM, specially the topic 'How much RAM'.

(ii) Input/Output Data Requirements

(a) Input: Single Terminal or Multiterminal

The IBM-PC or compatible comes with one terminal. What it means is that data can be entered in the computer only through the keyboard supplied with the PC. This is often sufficient for a small business where data entry requirements are not very heavy. However, to ensure that this would suffice, you would have to workout your input & output requirements.

Let us take an example of a hypothetical 'ABC Manufacturing Co.', manufacturing computer items like floppies, papers, tapes, etc. The business may be having on an average 1000 transactions in a month. Each invoicing may require 100 characters as shown in the table. For invoicing alone, 40 transactions (record) a day would require data entry of about 100 × 40 i.e., 4000 characters.

An average typist can type at about 40-50 words per minute, i.e., about 200 characters per minute on an ordinary typewriter. Entry of data, consisting mainly of decimal numbers, however, is more difficult. An average Data Entry Operator can type about 100 characters per minute i.e. about 6000 characters per hour. For a record size of average 100 characters, it works out to 60 records per hour.

Thus, average 250 records can be entered in 4 hours. Approximately same time would be spent in generation of various outp

TABLE 22.1

ABC Manufacture Co.

Invoice details

Field Name	No. of Characters	Example
Record No	6	001209
Invoice No	6	042349
Date	6	220488
Name & address of customer	40	XYX Pvt Ltd Co Connaught place, New Delhi 110 001
Particulars of items	15	Floppy disks
No of Units	4	0050
Unit cost	4	0045
Total cost	6	002250
Sale tax (8%)	4	0180
Gross cost	6	002430
Credit permitted (days)	3	030
Total	100	

like reports, charts, graphs, etc., which may be required for analysis purposes Thus, 250 records can be handled in an '8 hour' day by a Data Entry Operator. One keyboard with one display, and one Data Entry Operator is more than enough since only 40 records are required to be entered daily on an average.

However, invoicing may not be the only requirement, other requirements have to be similarly assessed & added up

If more than 250 transactions are taking place in a day, you have to run two or three shifts which may not be desirable for many companies.

An alternative to this is possible by adding one more independent terminal to your micro, for the use of another Data Entry Operator. Also you may like to go for multiterminal computer like IBM-PC/AT.

Apart from keyboard terminal, there are other input devices. For graphics application, a mouse &/or an electronic tablet &/or a digitizer may be very useful. Please consult the appropriate chapters including the one on keyboards.

Monitor

Depending upon your requirements you would have to decide on the colour, resolution, screen size etc., of the monitor. For text requirements only, monochrome is best, however, graphics would require a colour monitor with good resolution For further details, please consult the chapter on monitors.

(b) Output Requirements

Printer: If the volume of printing is low, say 50 pages a day each page about 40 lines, total 2000 lines, an 80-column dot-matrix character by character printer with speed of 100 cps would be sufficient. To print 2000 lines X 80 characters i e. 1,60,000 characters it would take 1,600 seconds i.e less than 30 minutes.

TABLE 22 2

Another little more versatile example

DEF Co Ltd maintains following files for its business. The fields and memory requirements for each type of file are shown

Field/application	Number of files	Number of charectors in each file	Total memory requirement (Bytes)
Customer file	2500 Customers	200	500,000
Product file	100 products	75	7,500
Invoice file (2500 customers x 2 orders/ month x 12 months)	*60,000*	*150*	*9,000,000*
Cash journal	5,000 payments	50	250,000
Word processing files			1,000,000
Program & System software			1,500,000
		Total	12,507,000 Bytes
		Say about	13 MB

So, a 20 MB winchester disk would suffice.

For higher volumes of output, 132-column printers with speeds up to 400 cps are available. For still higher needs, one may go for a line printer rather than a character by character printer. Where high quality of print (correspondence quality) is desired, a letter quality printer should be bought. It is,of course,expensive & slow compared to a matrix-printer. For graphics printout a plotter should be purchased.

For further details please consult the chapters on printers & plotters.

Storage Capacity: Various storage media available on micros are tapes, floppies, hard-disks, etc.

The storage capacity required would depend on the volume of data to be processed. For home application, with very low data volumes, a cassette tape would be enough. For average business applications, a floppy drive would be sufficient.

In our example of ABC Mfg. Co., the 1000 transaction would occupy 1000×100 Bytes, i e. 100K memory. Proper storage with sorting possibility in future needs three times the space & thus 300K is what it needs in our case. It can very well be stored on a floopy disk of 360K capacity. Keeping an upward margin for 50 per cent expansion in future, 2 floppies would be enough. However, if the company wants to store full year's transactions at one place, it would need 300 × 12 i.e. 3600K or 3.6 MB,or 5.4 MB with margin for expansion, which can be easily stored on a winchester hard-disk of 10MB capacity.

For still higher requirements, a tape-drive which can transfer data at high speeds may be required.

Tapes normally have a recording density of 800 to 1600 bytes per inch (bpi). Thus, a 2000 feet spool at 1600 bpi can store 2000 × 12 x 1600 i.e. about 40 MB (Actual capacity would be less due to gaps which have to be left between various records).

It s worth consulting the chapters on floppies, hard disks, tapes, etc. for greater details.

4. Cost-Benefit Analysis

Before you buy a micro & computerize your applications,you should make a cost-benefit analysis i.e. you should evaluate the total cost of installing & running of a computer systems viz-a-viz the savings or benefits which will accrue from the changeover

from manual to computer system. Computerization should be undertaken only when the benefits exceed the cost, resulting in overall saving.

In practice, particularly in India, this exercise would not show much saving on staff since, the clerical & other non-technical staff is often available at low salaries whereas the computer staff is expensive. However, savings do appear from increased efficiency & productivity. For instance, computerization may help in reduction in inventory &, regular & faster follow up of debtors, resulting in indirect but substantial savings.

To illustrate, let us consider a sample case of ABC Manufacturing Co. which wants to computerize its invoicing, accounting, inventory control etc.

(i) Benefits

Computerization would bring a number of benefits. You would have to anticipate all these benefits and convert them into monetary values. Assigning monetary value to each and every direct and indirect benefit is not a simple matter. Also, one user may be conservating whereas other may be very liberal. The element of subjectivity cannot be totally eliminated. Estimating the expenses is more easy than to measure in rupee, for example, the increase in efficiency which computerization results. In spite of these limitations, we shall consider and try to evaluate the following benefits:

(a) Increased Efficiency

Once the computer system is installed, implemented, and run smoothly, *a number of jobs would be performed automatically.* Processing of transactions would speed up. Backlog of invoices etc. would be cleared. Routine and boring activities would reduce. The efficiency of whole staff and management would go up. The management can concentrate on more important jobs of administration and decision making. For management also better management information for analysis & planning would be generated by the computer. The increase in efficiency would increase output and thus profit.

(b) Reduced Staff

Computerization may free some of the staff personnel who may be used on some other jobs. On the other hand, computeri-

(b) Software: Application packages, as per user's requirements have to be bought separately from the market. Some computer suppliers do offer common packages free-of-cost with their system, however, you may have to later buy other packages.

The cost of software may be calculated in the same manner as for hardware, i.e., by amortising the software cost over five years & also adding the interest on the software investment.

(c) Maintenance of Hardware

Generally the user enters into a service-contract with the supplier. The annual payments of this contract & the cost of defective parts replaced (if not included in the contract) constitute the main costs of hardware maintenance.

(d) Maintenance of Software

The updates for the system software may be supplied by the computer-supplier free of cost, but the expenses on modification & changes in the application software have to be met by the user. The costs may be due to:

1. If you have bought standard packages, various versions having plus-points over the earlier versions keep appearing in the market due to software development by third parties & you may like to buy the latest version.

2. If your application package is custom built, it might require changes. The cost of changes may workout to be about 10% of the cost of application software. The changes are required due to:

(i) You could not fully express your requirements initially, i.e., at the time of first preparation of the package.

(ii) Your software developer might have not fully understood your requirements initially.

(iii) With constant use, errors do appear in the program which have to be corrected.

(iv) With experience & knowledge acquired with constant use, the user may desire to upgrade and modify the program to include other or more advanced applications.

(e) Consumables Cost

Consumables like computer-paper, printer-ribbon, floppies, boxes for storage, tapes, disks, etc., have to be bought regularly.

Although the expenditure on these items depends on the computer usage, it works out to be about 2-3% of the micro-cost per month. So, for a micro say of about Rs. 50,000/-, the expenditure on consumables would be around Rs. 1000-2000 a month.

(f) Miscellaneous Expenses

Certain items like electricity (cost of airconditioning, power to computer, lights etc.), rents for housing the computer & staff, sanitation, & so on, also require expenses. If the site is owned, then the market value ot rent should be included.

(g) Staff Costs

Computerization would necessitate permanent employment of computer staff like Programmer, Operator, Data Entry Operator, System Analyst, EDP Manager & others, apart from hiring a consultant etc., as & when the need arises. They all cost extra in terms of salaries & other benefits which have to be given to the staff.

(h) Installation & Implementation Costs

Installation: This would include costs such as charged by the supplier installing the system.

Training: If some of your staff personnel are being trained, you would have to spend on their training either through computer supplier or a training institute.

Conversion Cost: Moving from old to a new system may require scrapping of old forms, files, reports, etc. & also transferring files to the new system.

Consultant's Fees: May be you engaged one for selecting & implementing your system.

Upgrading Cost: In future you might have to upgrade your system to accommodate growth. You would require; apart from additional software; the additional hardware, staff, supplies, etc.

Unforeseen Cost: Depending upon your application & system, you may come across some items or need which you could never foresee. A little margin should be kept for that. In fact the thumb rule is, be slightly conservative in your estimates of the savings in time & money you expect from the computer.

(l) Cost of Site Preparation

A computer would require preparation of a special site, preferably free from noise, dust, humidity and high temperature. Depending on individual choice, esthetics would also have to be considered.

Airconditioning is required because high temperatures are damaging to microprocessor chips & other components of a computer. Humidity creates fungus, and dust can jam various mechanical devices. Computer floor is generally raised to allow undergrounding of cables and wires so that they do not cause obstruction in free movement of computer users.

Example:-ABC Manufacturing Co. Ltd.

	Cost of Computerization Fixed Costs:	Rupees	
1.	Computer hardware say IBM-PC/XT or compatible with a dot-matrix-printer & colour monitor	60,000	
2.	Airconditioner (1), voltage stabilizer, electrical fitting, furniture, site preparation etc.	50,000	
3.	Software (application programs, not pirated !)	15,000	
4.	Initial lump-sum investment (1+2+3)	1,25,000	
	Running cost (one year & monthly)	**Yearly**	**Monthly**
5.	Depreciation (computer software, hardware, airconditioner etc all depreciated over 5 years We presume that the software is backed up so that it may last 5 years)	25,000	2,100
6	Interest on Rs. 1.25 lakhs @ 18%	22,500	1,875
7.	Hardware maintenance (including airconditioner etc) 10% per year (say you have a service contract)	12,000	1,000
8.	Software maintenance @10% of software cost	1,500	125
9.	Staff		
	1. Operator/programmer @ Rs 2000/- p.m.		2,000
	2. Data entry operator @ Rs. 1500/- p m.		1,500

10		Consumables & supplies like storage media, ribbons, papers, print wheels, fuses etc.		1,500
11		Misc (e g power & electricity, cleaner etc.)		1,000
12		**Total monthly running expenses (5+6+7+8+9+10+11)**		**11,300**
			Say	**12,000**
		Benefits/Savings due to computerization :		
13		Staff reduction		
	i	Say one clerk out of 3, writing accounts books		1,250
	ii	One clerk preparing invoices & outstanding bills statement		1,000
	iii	'One clerk out of two preparing inventory ledgers		1,000
	iv	Saving of 25% on a manager's salary of Rs. 5000/- p m		1,250
14		Reducced Inventory 20% reduction in inventory of Rs 25 lakhs so far maintained, i e. Rs 5 lakhs. Interest thereof @ 18% i e Rs. 90000 per year.		7 500
15		Regular follow up of debtors & better recovery of turn over of 2 crores. A week's average reduction Interest thereupon @ 18% i e. Rs 70,000 p a ,		12,000
				24,000
16		**Total monthly savings due to computerisation (13+14+15)**		
17		**(+) overall savings due to computerisation (16-12)**		*12,000*

Thus, ABC Mfg Co would save about Rs. 12,000 per month if it opts for computerisation

5. Selecting Models/Suppliers

Once you have decided on your requirements & how they would be computerised, & the investment you are willing to make, the next step is to look for a good micro & a good supplier.

Decision about purchasing a computer is very crucial. If a right decision is made, you would get extremely benefited, however, a wrong decision may cause chaos and wastage of time and money invested on the computer.

There are at least hundred different personal computers in the market. With so many makes available one gets confused in selecting a right one for his purpose.

New & improved models at lower & lower prices are being introduced every other day in the micro-market. It is very difficult to keep oneself up-to-date about all the models, their features, prices &,the newer accessories.

The computer market, apart from large number of models and suppliers, is full of jargons, misleading advertisements and conflicting claims. There is much bigger fleet of suppliers and models than can really assist the buyer in selecting a proper model.

The new buyer is not familiar with the vast variety of these models & hence, cannot distinguish on merits one from the other. He is likely to buy a wrong computer if he selects just like that However, once you have defined your applications precisely, & studied & implemented certain important criterion, often your choice would be limited to 4-5 models or so

You should examine more than one supplier for each make of the computer you have decided. Also, you should decide on at least three makes.

Let us now discuss these criterion.

Misleading Ads

Your first source of information about various models & suppliers may be the advertisements from suppliers

Many suppliers spend lakhs of rupees on advertisements to attract buyers However, such ads give little useful information, & often even mislead. They tell only part of the truth about how their model is better than others. Where it lacks is never mentioned.

They cash on the ignorance of the buyer about computers. Some micro manufacturers are trying to establish in the micro market by giving an impression that their model is a general purpose computer, even when it is really not. The buyers, being ignorant about how the computers differ, frequently believe these claims

For example, you may come across an ad where one model 'A' may claim in comparison to other Model 'B', to have better disk facility, keyboard, & features like serial & parallel ports. But

printer, a floppy-disk drive, a video screen, storage devices like floppies & hard disks, etc. You have to later build-up the system by paying separately for these items so that the computer can be useful for your work. In fact, it is little shocking for a new buyer to discover that often the total cost of accessories is more than the cost of the computer. It is possible that a good disk-drive system & a good printer may cost more than the computer.

Thus, the base price alone is not important & one has to seriously analyse the cost of expanding the system. Many sellers 'catch' the buyers through attractive advertisements about their 'cheapest' & 'best' computers. One has to be careful. The best way is to specify your requirements & then compare price of the various systems which are complete in the sense that, without adding-on anything else to them, they can meet your requirements.

Sometimes a micro is offered at extremely low price due to other reasons also. May be the manufacturer is leaving that line of production, or the dealer is winding up, or a particular model is getting outdated and the stock should be cleared somehow. You must be a little skeptical and must checkup the reasons if the price for a computer is extremely low, compared to the current market prices.

Buying Computer Proper

Sometimes it is economic to buy only a computer-proper (called a base computer) from the manufacturer & accessories from other suppliers, since the computer supplier often charges more for the accessories. For instance, printers, interfaces, video displays, disk-drives, etc., are sold by a number of independent suppliers, other than IBM-PC or compatible suppliers. You may save substantially with this approach. However, some micro-sellers do not encourage it & the warranty on your micro may become void. And worst, they may not enter into a service contract with you if you buy accessories from others. You have to therefore, examine pros & cons.

Future Arrivals

Micro manufacturers keep announcing models which would be introduced 'very shortly' or in 'near future'. It is advisable not to wait for these models to come to the market if your requirements can be met with the one presently available. The reasons being that first, the 'near future' may mean anywhere from one year to

what 'A' may not mention is that it has single colour display, crude graphics & it is very expensive to upgrade it for high resolution graphics. The order model 'B' may display in colour, has built-in high resolution graphics, & thousands of graphics programs are available on it. In the complete analysis in fact, model 'B' is far superior to model 'A' which 'A' shall never mention

Thus, you should not much rely on the claims made in the ads, you have to look elsewhere for the correct information to make a correct selection.

Magazines, Books, User Group

You should check up if there is some computer user or a group of users in your vicinity with whom you can interact. Whether there is a good magazine for adding to your knowledge In addition to popular magazines, hundreds of books on computers are available which describe & dissect various models in details. It is worth visiting a couple of shops.

Some magazines like 'Computer Age', 'Dataquest', 'Computers Today', 'Business Computers', published in India give fairly up-to-date information to the Indian users, & others like 'Microcomputing', 'Personal Computing', etc., cover almost the whole world. You may like to subscribe to at least one of them to keep yourself refreshed.

Expansion and Tag-Price

A major consideration for computer cost is how much you would have to spend later, say for expanding the system. A computer presently costing a little more may offer expansion & additional equipments at low costs.

One should not be carried away by a computer's 'tag price' which may be quite misleading One devious seller may quote very low price which probably does not include a couple of essential accessories needed for running the computer. It is like quoting for a shoe without laces. Also they may quote for lesser than the amount of RAM needed. The other seller may quote high after he has understood your requirements completely & has included them in the price quoted.

In the computer market, one has to distinguish between what is called the base price of the computer which would not include a

printer, a floppy-disk drive, a video screen, storage devices like floppies & hard disks, etc. You have to later build-up the system by paying separately for these items so that the computer can be useful for your work. In fact, it is little shocking for a new buyer to discover that often the total cost of accessories is more than the cost of the computer. It is possible that a good disk-drive system & a good printer may cost more than the computer

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five years & by the time it really becomes available to you, you would have already saved a lot if you had computerised with an old model. By then, you may dump the old model & go for the new one. Secondly, the rate of obsolescence in micro-market is so high that a model of 'near-future' is bound to become obsolete sooner or later. Buying a present model may at best make you behind by a couple of years or a couple of models. So if you need a microcomputer, buy it now.

Once you have decided which computer to buy, the next step is—where to buy it from?

Manufacturers

Most of the big manufacturers do not sell directly to the customers unless it is a quantity order. This is specially true in countries like USA, UK, etc. However, in India, one can buy mostly straight from the manufacturers.

Dealers & Retailers

Micros are now largely being sold by representatives of manufacturers. It has already become like buying a TV or freezer in USA but in India, it may still take some time to come to this stage.

If you are buying from a dealer, do check up whether he can provide strong service support. Some suppliers are interested in only selling & making quick money. It is not rare to find suppliers who do not even know about computers. This happens because manufacturers are sometimes not very choosy as to whom they should appoint their authorised dealers. Just by seeing good distribution and marketing network of the dealers, they are authorised to sell, even when they lack necessary experience and expertise.

On the other hand, there are excellent dealers because they are chosen after satisfying very stringent criteria of experience, expertise, service-support etc. IBM, for example, the largest micro manufacturer, ensures that

Service

Before you decide upon a computer, be sure to check as to who would maintain it and on what terms and conditions. Servicing may be done by the manufacturer, his dealer, or an independent third party service-organisation. Often you have a choice to select.

machine at their sites. Some guarantee free replacement of machine if yours cannot be repaired immediately, some replace defective parts free of cost, some charge for these parts, and some others make you wait very long for spare parts to arrive. Some offer round-the-clock service, available within few hours of demand, some do not make any commitment and some make you wait for days together. Some contracts guarantee you for the complete computer system and labour, some others only for labour.

Service contracts may be either on yearly lumpsum payment basis, or the yearly charges may vary from about 10 to 20 per cent of the overall system cost.

If you think it is exhorbitant, you have a choice not to enter into a service contract, and rather pay for parts and labour as and when you need them, which may turn out to be cheaper. However, you cannot bank heavily on this approach since you can not anticipate how many breakdowns your system may suffer. May be, eventually you end up paying more than you would have paid for a contract. But a lot depends on your experience (& luck!).

In practice, a buyer having a service-contract is given better-service by the supplier than the one not having it. A customer with service contract is given preferential treatment, and the non-contract customer may have to wait for long periods before his system is put back in working order. So, if you rely heavily on your system and a breakdown, even for short periods, involves heavy losses, you should preferably go for a service contract.

Other Users Experience

It is not easy to answer which micro is good and which is bad. The supplier may be asked to give you reference of users of that computer. You may consult them, hear their experiences and benefit from them. However, one should remember that the supplier will not give you references of dissatisfied and disgruntled users

The Intuition

Some times it is possible to measure the competence and expertise of a supplier from the 'way' he tries to sell you the

system. Would he himself train you and your staff or does he recommend a training-institution and made-easy manuals for self-study and learning? Can he supply additional hardware, software and spares? Does he really take interest in your problem & try to solve it?

Documentation, Manuals & Teaching Aids

Some micros are provided with teaching aids which help you in learning & programming a computer. If you want to do the programming yourself, do look into the quality of these aids known as 'Computer Assisted Instruction' (CAI).

Often, there is very little & insufficient information available to the user, other than the manuals supplied by the computer seller You should check up if you can get information regularly in future from the seller. Whether there is some user group with whom you can interact.

6. Demonstration

You should select about 3-4 computer suppliers & then request them to demonstrate their system with your applications, at your site. Evaluation of a computer at customer-site is more near the truth. If the hardware & software can be easily operated & is understandable to you at your site, it would make you more confident. Also, the initial apprehension which you or your staff may be having about computers would disappear.

7. Installation and Implementation

Once you have decided upon a model/supplier, the system has to be installed and implemented at your site.

The number of micros in the market is very large. A trend is growing among the suppliers to leave the installation of the system to the customers. There is nothing unfavourable to the customer in this practice since installing a micro means nothing more than connecting the CPU with screen, keyboard, and printer; through a few cables and plugs, which can be successfully done by a little experienced user. However, if you are an inexperienced beginner you should insist that the system is installed & started by the supplier.

The system as a whole including the peripherals, such as printer, should be working. If you yourself try to install or start it but are unable to do it, not only has time been wasted but you and your staff may become fearful and apprehensive of computers. It is not a good first impression about computers.

The cost of the computer should include (& it is most often the case) training and follow-up visits by Service Engineer from the supplier, so that the problems and questions you might have during the first few months of installation are sorted out. If the price of the computer includes installation charges, since you do not have to pay extra, there is no point in sacrificing the opportunity of installation by the supplier.

Generally, the supplier guarantees free customer site service for about a year or so, after installation of the system You do not have to pay on service contract from the day you buy a micro. Sometimes, free service is guaranteed on the terms that the equipment has to be taken to supplier's work-site Since you cannot take your system to supplier-site every now and then, the guarantee is redundant. Effectively it means that you would have to enter into a service-contract from the day of installation.

During the installation or a trial run, you should ensure about the reliability of the systems. The number, or what is called the frequency, of breakdowns has to be examined If the system malfunctions or breaksdown often, it is a serious cause of concern. In fact, it is often taken as a thumb rule that a computer system, if it's giving trouble free performance during first 2-3 months, it would mostly be like that in future also. Any fault etc. it will show within first 2-3 months.

8 Training

Self training through good self-teach manuals and special training-software supplied with a program is a good idea, particularly if you are a little experienced and very confident.

However, it may take you longer to learn this way. It may be difficult to fully appreciate or master the more advanced features of the software program. You may miss on certain tips which the expert trainer discovered only after long experience with the system.

Some software programs can be customised to suit your requirements to an extent but you may find it difficult to do it

yourself. Hence, having an expert advice or training, preferably on-site, may be very helpful.

Like installation, the cost of training at supplier's site or customer's site is also normally included in the price of the micro. Training courses run by independent training institutions etc. can also be availed of, but there is no substitute to personal training geared to your specific requirements.

9. Insurance

Insurance covers you against various types of risks and dangers to the hardware as well as software. Insurance against loss of data, particularly the important data is advisable since, accidental loss of data is very frequent. Even a slight fluctuation in power supply can be disastrous.

In practice, proper coverage is very expensive and even difficult to get In fact, intensive data back up than insurance is a better solution for data protection. Copies of data-disks should be made regularly. Even printouts are advisable.

23.
Selection of Software

There is so much software available today (almost 50,000 packages), not all is that good & therefore, one is likely to make a bad selection. Apart from loss of money, the poor software would mean loss of time and opportunity which cannot be recovered. There are certain guidelines which should be kept in mind before selecting a package.

Assess Requirements:

The first and foremost thing is to assess your requirements What are your needs & applications? List them in order of priority You should be as imaginative as you can in the tasks you would like your computer to perform since the tasks which can be doen with a computer are virtually unlimited. Also, range, quality and sophistication of software available in the market is so wide that you can be sure that your requirements would be met.

Refer Books, Magazines, Shops, Users:

The next stage is to survey the magazines, visit a couple of computer shops and meet the computer users, may be in your vicinity you have a few. The interaction will enable you to know the kind of software available and going around. Good magazines give details about all the new software coming to the market, also they often review the old software and its suitability.

Memory Requirement:

Every application program needs a certain minimum amount of memory for execution of the program. Generally the packages mention on their labels, the needed memory-sizes so that before buying one, you can ensure that your computer would be able to run it successfully.

For instance, a 48K CP/M operating system would require 48K (RAM or ROM or any combination) Similarly 16K BASIC interpreter would require 16K. However, when both of them are put together, a total of 48K (maximum of the two) would be sufficient.

Check up that the memory requirements of the software are met by your hardware. If a program requires 300 KB memory and your computer has only 128K (RAM + ROM), then better think

of first upgrading the hardware by addition of memory chips or boards, or select software which requires less memory.

Work Space:

Many of the applications require what is called a 'workspace'. Programs that work for sorting, merging, selection, etc. require more space than just the occupation space. They have to spreadout or 'Scratch' for doing such functions The larger the workspace, the greater the speed of operation

Generally such a program needs a storage space which is twice the size of the file on which it is operating. If lesser than this size only is available, either the speed would drastically reduce or the program will stop mid-way.

You should check up these details before buying a software. For example, while buying a mailing list application program, you should examine the storage limitation of the disk on which it is stored. The space would decide the maximum size of the file (or the number of entries) that the disk can permit.

Survey the Options:

Once you have surveyed and selected a broad range of packages for your applications you would find that for one particular need, there are still tens of application packages.

These options you have to evaluate critically. Again the magazines, books and specially other users would be a great help Do not be carried away just by the words of the supplier.

Documentation

Documentation consists of manuals, books, guides etc. They explain how the system would be implemented, operated & safeguarded. Manuals should be well written, clear, properly indexed, cross-referenced & should have illustrations. They should explain all functions including error messages and aim towards how to obtain best advantages from the system.

The first-time user needs step-by-step instructions with good tutorials. A good manual should cover this approach.

Multiuser & Networking

A multi-user system is the one in which several screens share one central data processor.

A networking system is where several microcomputers are linked together, each with its own processor.

Some packages permit more than one screen to share the centrally held information. Some of these allow multi-user operation, and some networking. Some can manage both.

Some packages can link up with other software packages to exchange data. A typical use for such a link is when you want to create word-processed documents on information from your database system.

Spooling

This feature permits printing of reports & working on the screen simultaneously. Some application packages may have this feature. Often, the packages which claim to possess the spooling feature actually store the reports on disk for printing later instead of permitting simultaneous printing & working with the screen.

Software & Hardware

Software is rarely written by hardware manufacturers though, they may sell it under their name. Software is mostly written by specialist software companies. These companies sell direct as well as through dealers.

If software and hardware are bought from different suppliers, it often happens that in case of malfunctioning of your system, the software supplier may put the blame on hardware supplier & vice-versa. To avoid this, if possible, try to buy hardware and software from the same supplier. It ensures better support.

To satisfy that the package is good for your application, you should see it in operation either at supplier-site or at one of the user's site. By visiting & discussing with another user, you can have an independent opinion on the quality and usefulness of the software and also the history of service provided by the supplier.

Compatibility of application programs

The compatibility between programs and computers should be associated on one to one basis & not flatly between two computers. What it means is that one should clearly mention whether a specific application program is compatible with a specific computer. This is more precise & flexible. For example, one IBM-PC application program might be compatible with two different micros while another IBM-PC application program is only compatible with one of them.

Application program compatibility often fails when the program's display capabilities are tested since, various computers assign variable display functions. Therefore, in case of any doubt, the compatibility claim should be assessed through display capability also.

It is practically impossible for a computer manufacturer to test the compatibility of every application program with his computer. Similarly each software writer also cannot try his program on every computer in the market. Fortunately for the user, a program's compatibility with a famous machine like IBM-PC is generally claimed and advertised clearly and the claim is worth believing. However, for other machines, it is for the user to determine whether the program will run alright or not.

Supplier

Once you have identified the packages which satisfy your requirements, you have to look for those suppliers who are willing to try and understand your applications rather than those whose main interest is simply to 'sell'. The supplier, apart from offering the packages at competitive prices, should be able to undertake installation; provide or arrange training and; offer continuous support. Training from a third party is not satisfactory since the supplier alone knows the ins & outs of his products & he alone can share useful 'tips' acquired through constant experience with the package.

Demonstration

After you have made a preliminary selection of a package & a supplier, it should be preferably demonstrated at your site. The software may be quite OK at supplier site with the hardware but you should rather run it on your hardware for foolproof working and confidence. All problems should be brought to the notice of the supplier and get rectified. If major problems occur then you should rather think of an alternate software.

MAINTENANCE OF SOFTWARE

Application software porgrams need maintenance due to two reasons:

(i) They may contain errors or bugs which could not be detected in normal use of the software.

(ii) The software writers keep adding special features and offer new versions of the software.

(i) Bugs

Since programs are written by human beings, almost all programs particularly long and complex ones, contain bugs. A programmer, howsoever experienced, cannot test all the possibilities a program can offer and errors do remain intact with the program. Some of these bugs may appear under exceptional circumstances, when the program is being run.

This is why, you should choose a software which has been tested and used extensively by other users so that, the chances of bugs are minimised. Lotus 1-2-3, dBase III, Wordstar etc. qualify on this account.

Once a bug is detected, the program is to be debugged (i.e. the error is to be corrected). This should normally be done by software designer. You should have a maintenance contract with the software supplier before buying.

(ii) Version

The software designers often improve or modify their own software so that it can become more useful and versatile. The user himself should not try to change a program since,new bugs may be introduced; unless the user thoroughly understands the program, is highly experienced, and is extremely careful while making changes. In any case all the changes made must be properly documented for future references

Your software-maintenance contract should guarantee you the supply of the latest versions having corrections, modifications and new features,over the software you had bought. The supplier should keep you informed about latest releases. In practice, you should yourself check up regularly with the supplier so that you do not miss the best Also checkup that your old data files can be used with the latest version before you change over to the newest.

After Purchase Care

A number of processes are involved with regard to new data or programs stored on magnetic media like floppy, hard-disk, tape etc.:

Loading

Once you have bought a package in which the program comes stored on a floppy or hard disk, there are two tasks to be performed.

(1) The program has to be installed on your computer;

(2) You have to enter your data and produce reports etc.

The loading is quite difficult if you have no experience. However, your hardware and/or software supplier would be able to help you

Labelling

The moment new data or program is saved on a media, the media should be indentified by sticking a label on it, mentioning the contents and the data. It is essential for future search and use.

Backup

Anytime a new program or data is received,it is essential that they should be backed up (copied). If new data is created at the end of a working period, a copy of it should be immediately made. The backup,or original data,should be kept at a safe place.

This ensures that if data and program is lost or corrupted, it can be easily recovered from the last back-up. Without this safeguard the data would be permanently lost.

Backup can be carried as a function of the operating system but it is slightly complicated for the beginners. However, some packages offer help in backing up by providing it as a 'menu' option. Some packages even go to the extent of 'forcing' you to make a backup at some important points during data-processing.

Storage & Security

All media, containing programs of data should be handled carefully. They should be stored in proper containers. Standard storage boxes are available in the market for each type of data-media. Confidential data & programs should be stored at a safe place and kept under lock and key.

Accessibility to Documentation

All the documentation like manuals, books, guides etc. provided with the software, and any important references you might add later, should be available near the computer. They should not be removed from their place by unauthorised people since, you may require any document during an emergency such as system malfunctioning. If it is not available at its desired place,

it may irritate you and even cause disasters (You do not get it when you want it most! Peter Principle!). If possible, keep duplicate copies of all documents at some other place, for general reference, but do not let computer room documents be displaced Also, the documentation should be complete and up-to-date.

Pass Word

Passwords are used to prevent unauthorised access to the computer system. However, the authorised user should frequently change them, since they become known quickly.

One can use two levels of password, in case,some parts of the system are more sensitive than others. Even regular operators can't have access to more sensitive information when they 'need not'.

FUTURE OF SOFTWARE

The future is very bright as far as application software is concerned. More powerful programming languages, more versatile operating systems, better database management systems & query languages would be forthcoming.

The cost of the software would reduce gradually as the user base widens and more people opt for microcomputers. The reduction in prices however, would not lower the quality of Software. It would rather improve as more and more software writers join the industry.

More & More standard readymade software would be available and reliance would be more on this type of software rather than the costly custom-built software.

The improvements in microcomputer memory capacities would encourage some of the important packages to become part of the computer hardware. For instance, word-processing package may be put permanently in the ROM,like the operating system is put in ROM today.

The programmers are also going to have good time. Sophisticated software tools would enable them to create programs automatically or semi-automatically, so that the production-cost of programs would reduce and quality will improve due to this factor also.

The future would bring a central computer with an extremely large database and very powerful software, accessible through networking to any computer user having his computer linked to the network, like the telephones today. The scientists, engineers, doctors, other professionals and even a general user would be extremely benefited from such large scale information.

TERMINOLOGY

Access time: Time taken for a particular infor...tion to become available.

Accumulator: A working register.

Adapter: A device used to control or interface a piece of h...dware to the computer

Add-on: The process of increasing the memory capacity, modifying the architecture, or upgrading a computer system's performance capabilities by adding circuitry or components to the system

Address: A number that identifies a single location in computer memory.

Address bus: A bus that transmits an address and lets the CPU select an individual location in the memory.

Address word: A set of bits used to determine an address.

ALGOL: A high level computer language, generally used for scientific applications

Alphanumeric: Letter and number characters, also taken to include other symbols like punctuation, mathematical operations, or other symbols available on a computer keyboard.

Application Software: Computer programs written to perform specific tasks. Generally very cheap & mass-produced for games, education, business or personal computing purpo s

ASCII Code: American Standard Code for Information Interchange. A binary coding system that converts alpha-numeric characters & some control commands into numbers which the computer can understand.

Assembler: A program that translates an assembly language program into a machine language (Binary code) program

Assembly (Symbolic) language: A low level computer language in which symbols (mnemonics) are used instead of n_ bers to represent program instructions. Human can understand it more easily cor pared to machine language.

Architecture: A description of a chip's hardware parts, how they are connected and how they communicate with each other.

Artificial Intelligence: The capability of a computer to perform functions that are normally attributed to human intelligence such as reasoning, learning, innovation & self improvement.

Auto repeat: When a key is kept pressed, the corresponding character keeps appearing repeatedly on the screen until the key is released

Backup: Duplicate copy of a file or program or diskette onto a similar separate storage medium, so that a copy will be saved in the event of an accidental loss or failure of the original.

Bank Switching: A technique by which a computer can use more memory than really available, by switching between different 'banks' or sections of RAM

Bar chart: *A graph in which quantities are represented as bars* (rectangular boxes) of different sizes.

BASIC: An English-like *High level programming language,stands* for Beginner's All Purpose Symbolic Instruction Code.

Baud rate: Bits per second Rate of data transfer. Also referred as BPS

Bidirectional Printing: The ability of a printer to print in both directions, from left to right and right to left alternatively. It increases the overall speed of printing.

Binary System: A number system based on two digits 0 & 1.

Bit: A BInary digiT, 0 or 1.

Blinking: Flashing or flickering of the cursor on a display screen, to attract user's attention.

Boot: To load the computer with the operating system.

Booting: A technique for loading a program into a computer memory.

Bubble memory: A magnetic memory that does not erase the information stored even when the power is turned off. Midway in price between floppy disk and PROM.

Bouncing of Keys: A fault due to which more than one characters appear on the screen even when the key is pressed only once.

Buffer: An 'intermediate' storage area to store data temporarily. For example, data sent by computer but not immediately printed by the printer is kept temporarily in printer buffer.

Bug: An error in a computer program

Bus: A set of wires to make a pathway which is used to transmit information among two or more devices

Byte: Generally a group of 8 bits representing an alphanumeric character.

Cable Connector: A device that provides the male and/or female plugs necessary for connecting cables

CAI: Computer Aided Instruction — Teaching by computer.

Card: Additional printed circuit board (PCB) which has interface, memory & other facilities.

Cassette: A small plastic box (cartridge) containing magnetic tape on which programs & data can be stored & read

Cassette Drive: A cassette player/recorder used to write or read computer information

Character: An alphabet, number, punctuation or any other symbol which appears on the screen by pressing a key on the computer keyboard.

Chip: A wafer of silicon, etched with circuits A single integrated circuit.

Circuit: A pathway along which electrons can flow

Circuit Board: (Printed Circuit Board) A rigid card on which different electronic parts are mounted Printed or etched copper tracks connect the various parts.

Clock: An electronic circuit in a computer, generating signals for timing & synchronizing

Coaxial Cable: A cable consisting of one conductor, usually a small copper tube or wire, within and surrounded by a shield made of a separate electrically insulated wire.

COBOL: COmmon Business Oriented Languages. A high-level language used on computers primarily for business applications

Compatible configuration: The ability to work together

Command: An instruction that tells the computer what to do

Compiler: A program that converts high level programming language into machine language which can then be run on the computer.

Computer Graphics: Graphs, charts, drawings etc. generated by computer. These graphics can be displayed on the video or a hard printout taken from a dot-matrix printer or a plotter.

Computer System: A complete computer made up of hardware components like monitor, printer, keyboard, disk drive etc. which make the computer usable.

Configuration: A set of machines which are interconnected and programmed to operate as a system.

Console: A monitor Generally the keyboard & the video display.

Control Bus: A bus that transmits control signals

Control Unit: That part of CPU that directs the fetching and executing of instructions, by providing timing and control signals.

CP/M: One of the first operating systems running on a number of microcomputers

Crash: Premature end of a program due to an error in computer program or hardware A complete malfunction, worse than a bug.

CRT: Cathode Ray Tube A tube like the one in a home TV, used to display computer input/output

Cursor: A moving character displayed to show where the next output will be displayed

Custom Software: Programs designed by special order to serve a user's specific requirements Much costlier than standard packaged software

Data: Information which can be processed by a computer. It can consist of numbers, letters, statements, symbols etc. which a computer can interpret.

Database: An organised collection of data.

Database Management System: A computer program that can manage (organize) & store the database so that it is easily accessible by one or more computer programs

Data Address: An address whose location contains the value (the data) to be operated on by the program

Data Bus: A computer highway along which data travels into and out of CPU.

Data Entry: Entering data into a computer.

Data Processing: The process of translating data into machine language so that the computer can then process it.

Daisy Wheel: Print wheel used in letter quality printers generally having 96 characters on its arms

Daisy-Wheel printer: A printer which uses a daisy wheel for printing characters Produces very good quality fully formed characters in contrast to dot-matrix characters.

Debug: To correct errors.

Documentation: Information about computer software/hardware.

Decimal Number System: The familiar number system using digits from 0 to 9 with a base of 10.

Dedicated: Designed for a particular purpose or application. A dedicated wordprocessor is specifically programmed for word-processing

Decode: To interpret an instruction

Default: An assumption made by a computer when it is not given specific instructions by a program or a user.It is generally the most common or safest choice. For example, a word processing program may type text in single space if no instructions are given otherwise, though the program may print in double or triple or more spacings. Similarly the IBM-PC uses the default drive 'A' unless it istold to use drive 'B'.

Delete: To remove data from context; to remove a record from a file of records or a file from a library of files.

Desktop Computer: Microcomputer used for business tasks, a computer which needs a desktop space (4' x 2½') compared to large space required by mainframes & medium computers.

Device: Any component of a computer system.

Digital: A system that uses only the numbers 0 & 1 for variables. Any information is represented by a series of zeros & ones.

Digitizer: A deivce that converts analog measurements, such as those found in a line drawing, into digital form for feeding into a digital computer.

DIP: Dual in line package. Packaging that houses chips and connects to the board with prongs. A type of IC pakaging having two parallel lines of pins.

Directory: The list of all files, which is itself a file, on a computer storage medium, such as floppy or hard disk.

Disk, magnetic: A flat, circular storage medium capable of storing information.

Disk Drive: A machine which reads information from a disk & writes information onto a disk.

Disk Operating System: A master program that controls the execution of other programs in a computer with disk drives.

Display: The data display in visible form on a CRT screen. Also a screen.

DOS: Disk Operating System.

Double Density: Storage of information on a floppy disk so that the capacity is twice that of a standard diskette. This is done by doubling the number of tracks per inch, or doubling the serial bit density, or a combination of both.

Double Sided Diskette: A diskette that uses both of its sides for the storage of information.

EAROM: (Electrically Alterable Road-Only Memory): A type of ROM that can be both programmed and erased with electrical stimuli.

Electroluminescence: Emission of light from a phosphorescent material when electric voltage is applied to it.

Electronic mail: The electronic transmission of letters, messages, and memos from one computer to another computer at a different place & generally connected via telephone lines.

Electrostatic Printer: A nonimpact printer that employs electrically charged dots to attract ink which is then embedded onto the paper by heat and pressure.

Electrosensitive Printer: A non-impact printer that employs electrically charged dots to develop specially coated paper.

EPROM (Erasable programmable ROM): A type of memory like ROM that can be erased by applying ultraviolet light, & then reprogrammed.

Ergonomics: The study of the interaction between people and machines.

Error Message: A statement in words, displayed by a computer on the video screen when it has detected a syntactical or other error in an instruction or a malfunction within its own system.

Execute: To carry out or 'run' the instructions in a computer program.

Expansion slots: Special connectors provided inside a computer, peripherals can be added by connecting to these slots.

External memory or Mass memory: Mass storage devices like, cassettes, disks etc. which can store computer programs & data.

Fetch: The reading of an information by a computer.

File: An organised collection of information. Related records are treated as a unit & generally stored on floppy or hard disk.

Flag: An indicator that an equipment or a program has reached a certain condition.

Floppy disk: A thin flexible plastic disk coated with magnetic material and used for mass storage of data

Fluorescence: Emission of light by a material after ultraviolet or other short wavelength lights are absorbed by it.

Formatting: The process of organizing a floppy disk (forming sectors & tracks etc.) so that information can then be written or read from it.

FORTRAN: A high-level computer language generally used for scientific & mathematical applications.

Garbage: Data that has no meaning.

Graphics: Graphs, pictures, drawings, special symbols etc. that are displayed on a video screen or printed by a printer or drawn by a plotter.

Hand Shaking: A means by which a peripheral device and the computer can report their status during data transfer.

Hard Disk: A circular rigid disk made from plastic like material & coated with magnetic oxide. Used for storing information.

Hard Copy or Hard Print: Permanent printout of computer on paper.

Hardware: The physical parts of a computer system. The actual electrical, electronic and mechanical parts.

Head: Small magnetic device inside a floppy or hard disk drive that reads/writes information on disks.

High Level Language: An easy to use programming language, made up of familiar word & symbols, in contrast to low level language which uses numbers.

Home Computer: A microcomputer designed to be used at home. Runs both games & various personal applications.

Impact printer: A printer which forms characters by physically striking onto the paper through a ribbon.

Index hole: A hole in a floppy disk that indicates the start of the first sector

Ink jet printer: A non-impact printing technique which utilizes droplets of ink to form characters/graphics.

Input: Information fed into a computer

Input/Output port (I/O): The link between the computer and the outside world. The part of the computer which is connected to input/ output devices

Instruction: A statement that tells the computer what to do. Consists of an operation plus one or more operands.

Input device: A computer device used for entering information in a computer. Like keybord, cassette player, light-pen etc.

Integrated Circuit (IC): A piece of silicon that has several electronic parts on it.

Interactive: Having a dialogue with a computer system. The computer responds immediately to the input given by the user.

Interface: A standard connection between computer devices. A piece of hardware & software that permits communication between the computer & another device. For example, a printer interface allows transferring of information from a micro to a printer.

Internal Bus: A set of conductors within the CPU over which signals are exchanged among various components of the computer.

Interpreter: A program that translates each high level language statement into a series of machine instructions and then executes

those machine instructions before translating the next high level language statement. It is in contrast to a compiler which translates the entire high level language program into machine language program before executing it

Joystick: A game control device. A stick or lever, used to change the position of the cursor on a screen.

K: Measurement of memory size. Generally used instead of 'kb',1k or 1kb of memory is 1024 bytes (& not 1000 bytes)

Kilobyte: 1024 bytes.

Keyboard: A panel of switches or push buttons used to enter programs & data to computer.

Label: A group of 1 to 6 alphanumeric characters, of which the first must be alphabetic, used to identify a program name, statement of memory location.

Large scale Integration (LSI): The technology enabling more and more electronic parts to be put onto smaller and smaller chips.

Language: A media for communication. A computer language permits humans to interact with computer.

Laser Disk: A high capacity mass storage device written and read by laser.

Laser Printer: A printer technology that focuses laser beams to form images with a principle similar to that used in photostat copiers. Laser printers are now used as output devices for computers. They are high speed, high quality, and have relatively high cost compared to other printers

Light Emitting Diode (LED): A small device that produces a red light when turned on

Load: To transfer data or program from a peripheral device (say keyboard) to Computer's memory.

Light Pen: A means of input of data, drawings etc., by means of a sensor that is held in hand, with the tip of the pen in contact with the VDU screen.

Line Printer: A high speed printer that prints one full l[illegible] time in contrast to a normal printer that prints one char[illegible] time.

Liquid Crystal Display: A display screen generally used on small devices such as a digital watch.

Log off: The procedure by which a user ends a terminal session.

Log On: The procedure by which a user begins a terminal session.

Logo: *A high level easy to learn language, generally used by childern.*

Low level language: A computer language difficult to understand by humans but easy for a computer. It is at machine level i.e. *made up of binary digits or some symbols.*

M or Mega: A prefix for one million. One Mb is 1024 Kb. or 1048, 576 bytes.

Machine code: A numerical code into which instructions in any computer language have to be translated before a computer can execute them.

Mainframes: The largest & costliest type of computers.

Mass storage: The computer *information* that is stored on other media say a floppy or hard disk, than the computer's internal memory.

Megabyte: *1048,576* bytes.

Memory: *A set of physical locations that can contain numbers.* The part of a computer system (RAM or ROM) *which stores data.*

Microcomputer: A computer whose CPU is a single microprocessor. It also has memory & I/O.

Minicomputer: A computer in between mainframe & microcomputer in cost & size.

Microprocessor: *The chip that contains the CPU. It is a single small device that performs the functions of a CPU i.e. it contains the calculating, decoding & decision making parts of a computer* on a single chip.

Microprocessor system: *A microprocessor plus other devices to* do a specific task.

Mnemonic: *A* group of letters (usually three, some times four) *that symbolize an instruction* Easier to remember than a longer word.

Monitor: A TV or CRT which displays computer information.

Monitor: A program with which user can 'dialogue' with a microcomputer through I/O. The monitor also permits the user to run programs, examine & alter the contents of memory locations.

Motherboard: A circuit board into which many small circuits can be plugged.

Mylar: A kind of plastic used to manufacture floppy disks.

Machine language: Permutation & combination of binary numbers used to give instructions to a computer.

Matrix Printer: A printer which forms characters by printing a pattern of dots.

Menu: A multichoice questionnairre displayed on the screen by the program e.g. what do you want to do ? 1. Play games 2. Accounts 3.Appointments. List of options offered by a PC for the user to choose from. A program featuring 'menu' is described as menu driven.

Modem: A device used to transmit data over telephone lines.

Multiprogramming: Several programs are executed simultaneously on a single computer under the control of an overall system program.

In one kind of multiprogramming system, the system program uses the idle time of the computer to execute another program.

In other system, each program is allocated a fixed 'slice of time' say 100 milliseconds after which control is transferred to another program. A given program will generally need a number of these slices, which alternate with the slices devoted to other programs. This kind of multiprogramming is called time sharing.

Multiprocessing: A computer using more than one CPU. The CPUs of several computres linked together, or a single computer provided with more than one CPU, carryout parallel processing. Simultaneous execution of several programs or of several parts of the same program are carried out. (Number of calculations at the same time).

Nanosecond: One thousand millionth (billionth) of a second.

Network: A group of intercon[illegible]ted computers that can [illegible] information among themselves.

Nonvolatile: A type of memory where data is not lost even when the power is cut off.

Numeric data: Data that consists entirely of mathematical digits.

Off-line: Not directly connected to a working computer.

On-line: Directly connected to a working computer. A printer is on line when it is printing.

Operand: The quantity that is operated on (The object of the instruction).

Operating system: A master computer program which enables a microcomputer to control the execution of other programs.

Operation: That part of an instruction that tells a computer what to do (the verb of the instruction).

Output: Information processed by a computer & sent to output devices like video screen, printer, plotter or a storage device like a floppy disk.

Output device: A computer device used to take out the information processed by a computer Like, CRTs, printers, disks etc.

Package: A computer program with the documentation needed to run it

Parallel transmission: The transmission of a group of bits (usually a byte) simultaneously.

Pascal: A high level computer language used for general & business applications

PC: A general purpose microcomputer, used by one person alone. The term generally used for IBM-PC.

Pie chart: *A graph in which quantities are represented* as slices cut out from a circle.

PILOT: Easy to learn high level computer language. Generally used for educational purposes.

Pin: A connector in a DIP by which the microprocessor may be conneted to other devices.

Pixel: The smallest area on a video screen, generally a single dot, which can be controlled independently.

Plotter: A device capable of producing charts, drawings, graphics, bar charts, maps etc. Basically a printer designed to print graphs instead of alphanumeric characters.

Port: The place where another device can be connected to a computer.

Power supply: A source of energy to the computer & devices. Built from transformers & other parts, it converts AC into DC

Preventive maintenance: Precautionary measures taken on a system to prevent failures, rather than to fight them after they have occurred, by providing for systematic inspection, detection and correction of problems before they develop into major errors.

Printed Circuit Board: A board on which a number of chips (micro processors) are mounted &/or electric circuits are printed.

Processor: The part of a computer that fetches, decodes, & executes instructions. It contains the control, calculating & decision making parts of a computer.

Program: A set of instructions or statements to tell a computer how to perform a particular operation.

Programmer: A person who writes computer programs.

PROM (Programmable ROM): A type of ROM that is programmable by the user.

Proprietary program: A computer program (say an operating system or an application package), controlled by an owner through the legal rights of possession and title. Generally the title remains with the owner though, it is sold for use with the understanding that no disclosure of the program would be made to any other party without prior permission from the owner or agreement between the owner and user.

RAM: The type of computer memory in which any individual location may be accessed directly. That part of a computer's memory which can be altered at will by the user

Read: To nondestructively copy a number from one location to another, say from a storage device like floppy disk to computer memory.

Read/write memory: Same as RAM. Computer memory in which the user can store data or read data at will.

Register: A physical location that can contain a binary value.

Save: To store the information on some storage media like floppy disk.

Screen type: The technology of the display. For example:
(i) Cathode Ray Tube (CRT):
(ii) Liquid Crystal Display (LCD) &
(iii) Light Emitting Diode (LED)

Scrolling: Moving through information on a display either vertically or horizontally, to display & view particular piece of information otherwise not visible (though, it is in the memory of the computer)

Serial: One bit at a time.

Serial I/O: The transmission of a group of bits one bit at a time.

Soft copy: Information displayed on screen or recorded on tape, not on paper.

Software: Computer programs.

Speech Recognition: The process by which a computer decodes human speech to understand it.

Speech Synthesis: Artificial production of speech.

Stand alone program: A program that can be executed independently of an operating system.

Store: To copy a number from a register into a memory location.

Subroutine: A routine that causes the computer to return to the main program automatically at the point of departure.

Terminal: A keyboard & a video screen connected to a computer.

Time sharing: A computer system that can perform a number of tasks for a number of users simultaneously. In fact the CPU works only for one user at any particular moment but its response is so fast compared to the user's response that he is not aware of this fact & believes as if the computer is working for him alone.

Toggle: To reverse the state of a bit or switch.

User friendly: A computer software/hardware that is quite easy for even a beginner to understand & use.

User's manual: A book or reference describing how to use a piece of computer hardware/software.

Utility program: Program that helps the user in program or text writing.

Volatile memory: A type of memory in which data stored is retained only as long as power is supplied. The information is lost if the power is cut off.

Voice recognition: A system of sound sensors that translates the tones of the human voice into computer commands.

Window: An isolated part of a CRT screen that is used to display a particular piece of information independently from the rest of the screen display.

Word processing: Making use of a computer as a typewriter & for text editing.

Wrap around: The ability to automatically place characters on the next line when the end of the first line is encountered. A useful wordprocessing feature.

Write: To store data destructively in a location.

Write protect: A method of preventing writing or reading from a floppy disk. Used when the information stored on a floppy should be preserved since writing new information on it would mean erasing of old information.

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1. "... comprehensive ... those with no previous knowledge about computers introduced to fascinating world... in readable and friendly way... helps buyer in sound selection from plethora of Computers & application packages in the market... cost bare minimum .. every prospective reader & computer enthusiast able to afford..."
"Times of India" 9th Oct 1988.

2. "contains everything you wanted to know about computers but were afraid to ask...bare the mystery and dispel the anxiety that has grown around these modern day deities...step by easy step...guides the layman...while constantly reassuring the reader that he does not have to be an expert ...several comparative tables and diagrams...of immense help to citizens from all walks of life, be they business men, government officers, students, or just interested observers..."
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"Sunday National Herald" New Delhi 31st July 1988

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Dr. R.G.Saxena, Prof. of Commerce, NCERT, New Delhi.

5. "... going to meet long standing need of Indian population .. a starters book on computers... more comprehensive than Prof Rajagopalan's book "You and the Computer"... covers the latest in the field... would refer in lectures and to different and considerable audiences..."
Dr. Utpal K.Banerjee, Chief Executive All India Management association, New Delhi.

6. "... very happy to read .. congratulatory efforts... commendable achievement..."
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7. "... compiled painstakingly.. considerable care taken in producing comprehensive book discussing all basic aspects of computers in simple, lucid style... effort commendable and superb... excellent attempt at summarizing multiple dimensions of computer systems in a single compact book... recommending for purchase by our Customer's personnel attending training programs... and our training/software department who would suggest to various customers for reference and purchase.."
Sanjeev Bahadur, M.Tech,MBA, Areas Manager, HCL Ltd, New Delhi.

8. "... the book which I read at one go .. elaborate and exhaustive treatment of subject... remarkable... I am yet to come across any book so comprehensive and so practical... superb job.. unique and practical book..."
K.Srinivasan, IAS, Chairman, Computer Application Centre, Govt of Orissa. Bhuvneshwar.

9. "... provides basic information about computers, its various components, how they function and what they can do for us .. written especially for those with no previous knowledge .. introduces subject in easily readable and understandable manner... Wide coverage of subject .. very useful publication for those who want to refer to introductory book. We recommend purchase.."
A.K.Arora, Director Training, Deppt. of Personnel & Training, Govt of India, New Delhi.

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11. "... commendable efforts... good for administrators who want to understand essentials of computer hardware..."
Ravi Mathur IAS, Director Computers & Science & Technology, Govt of Rajasthan, Jaipur.

12. "... Successful attempt... explains basics of computers in general & personal computers in particular... especially useful for individuals having no prior knowledge. considerable efforts put to provide in-depth information about IBM compatible PCs, peripherals, interfaces, software, operating systems,... conceptual information... easy to understand... simple language... computer jargons explained in lucid way . beginner definite to get interested as he goes through..."
Prime Minister of India's Office through Dept of Electronics, Govt of India.

Recommended by:

- The Dept of Personnel & Training Govt of India for computer training at ATIs, GAAT, MIDA, IMG, SPIPA, AIM, MPAA, PSIPA, etc.

- Dr. N Seshagiri, Director General, National Informatic Centre for people undergoing training at NIC.

- Sh. T.N. Chaturvedi, Comptroller & Auditor General of India to all Accts/Audit Offices & libraries in the country.

- The National Council of Education Research & Training (NCERT) for CLASS project

- The Deptt of Education, Govt of India to State Education Secretaries/ Directors, NCERT, CBSE

- The Director Primary & Secondary Education Rajasthan for Higher Secondary schools.